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VOL. CXXXVI.—No. 3545] LONDON: FRIDAY EVENING, DECEMBER 7, 1923 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Wanted, Aircraft Examiners for Aeronautical Inspection Department. Only ex-Service candidates will be considered. Applicants must pass Ground Engineer's Examination Category B or D; must have previous experience examination aircraft metallic and non-metallic materials, detail parts, manufacturing processes and assemblies; sound elementary knowledge mathematics, machine drawing applied mechanics, including strength of materials, and previous workshop experience in engineering or allied trades. Salary £330 p.a.

Apply, SECRETARY, Air Ministry (D.D.A.I.), Alexandra House, Kingsway, W.C. 2, stating experience, ex-Service qualifications, &c. 4292

Assistant Engineer Required by the GOVERNMENT of the GOLD COAST for Railway Survey, for a tour of from 12 to 18 months' service. Salary £600, rising to £720 a year by annual increments of £30, and thence to £900 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Field allowance of £90 a year will be paid whilst actually performing the duties of the office in the Colony. Free first-class passages. Liberal leave at home on full salary. Candidates, not over 40 years of age, must be proficient in the use of the transit theodolite and level. Must have a knowledge of methods of running in curves and other matters pertaining to railway location. A thorough knowledge of topography is essential, and the best methods of obtaining the information and the use to which it is applied. Must have the ability to do ordinary draughting and compiling estimates.—Apply at once in writing, giving brief outline of qualifications and experience and stating age, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/12,054. 4293

Aberdeen Corporation Waterworks
EXTENSIONS, 1920.
CONTRACT NO. 17.—NEW INTAKE.

The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into a contract for the CONSTRUCTION of an INTAKE and SCREENING HOUSE, a 5ft. diameter CONDUIT, and ANCILLARY WORKS alongside the River Dee at Cairnton, Invernanda.

The drawings may be inspected and specification, schedule of quantities, and form of Tender obtained, on and after 4th December, 1923, on application at the Water Engineer's Office, 41½, Union-street, Aberdeen. Early application is desirable and no application will be given out after 18th December.

For each specification a deposit of Five Pounds sterling will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification and schedule of quantities provided, with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.

The employment of labour shall be in accordance with the conditions of the Unemployment Grants Committee.

Tenders, on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for New Intake," are to be addressed to the undersigned. No Tender delivered after 5 p.m. on 24th December, 1923, will be considered.

The Town Council do not bind themselves to accept the lowest or any Tender.

No person should Tender unless thoroughly experienced in the actual construction of extensive public works.

GEORGE MITCHELL M. Inst. C.E., F.G.S.,
Water Engineer

Water Engineer's Office,
41½, Union-street, Aberdeen,
24th November, 1923. 4214

City of Birmingham.
UNEMPLOYMENT RELIEF WORKS.
TO BRIDGE CONTRACTORS.

The Public Works and Town Planning Committee invite TENDERS for the RECONSTRUCTION of MASONRY and STEEL GIRDER ROAD BRIDGES over the River Tame and the Tame Valley Canal, together with APPROACHES and INCIDENTAL WORKS, &c., at Salford Bridge, Erdington. The bridges will have a width between parapets of 55ft., and the oblique span of the arch of the river bridge will be 72ft. The canal bridge will have a span of 40ft. The steel work of the canal bridge will form a separate contract.

Plans, specification, and general conditions (which include the Corporation's usual fair wages and conditions of labour clause and special conditions as to engaging unskilled unemployed men from the Labour Exchanges or Board of Guardians) may be seen, and copy of bills of quantities and form of Tender obtained at my office on and after December 6th, on payment of a deposit of £5, which will be returned on receipt of a bona fide Tender.

Tender to be enclosed in the special envelope which will be provided with the form of Tender, &c., and to be sealed and delivered at my office not later than 8th January, 1924.

The Committee do not bind themselves to accept the lowest or any Tender.

HERBERT H. HUMPHRIES, M. Inst. C.E.,
City Engineer and Surveyor.

The Council House, Birmingham,
4th December, 1923. 4290

East Indian Railway.

The Directors are prepared to receive up to 11 a.m. on Wednesday, the 19th instant, TENDERS for the SUPPLY of:—
STEEL BOILER TUBES.

Copies of the specification can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

O. E. LILLIE,
Secretary.

73-76, King William-street, London, E.C. 4,
6th December, 1923. 4314

Hartlepool Port and Harbour Commission.

TENDERS are INVITED for the CONSTRUCTION of a TWIN-SCREW STEAM HOPPER BARGE. Hopper capacity 400 tons, speed 9 knots loaded.

Tenders, together with plans and specifications, to be submitted to the undersigned, from whom further particulars may be obtained, not later than 25th January, 1924.

The lowest or any Tender will not necessarily be accepted.

By Order,
J. D. HOWKINS,
Engineer to the Hartlepool Port and Harbour Commission.

30, Town Wall, Hartlepool. 4231

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

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Experimental Researches in Propeller Cavitation—No. II.

Extended Piston Rods.

Public Works and Transport Congress and Exhibition.

PUBLIC NOTICES

County of London.
ROTHERHITHE TUNNEL.

The London County Council invites TENDERS for the CONSTRUCTION of a ROOF of STEEL and GLASS and of a MACHINERY PLATFORM of STEEL GIRDERS and CONCRETE in No. 1 shaft, Rotherhithe Tunnel.

Persons desiring to submit Tenders may obtain the drawings, specification, form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £3. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the drawing, specification, and other contract documents may be inspected before the payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 7th January, 1924, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
4319 Clerk of the London County Council.

Kettering Urban District Council.
SUPPLY OF PIPES FOR WATER MAINS.

The Council invite TENDERS for the SUPPLY of the following, viz.:—
1000 YARDS 9in. CAST IRON PIPES,
5000 YARDS 6in. DITTO,
200 YARDS 4in. DITTO,
together with sundry SPECIALS.

Forms of Tender and specification may be had on application to the Council's Surveyor, Mr. T. Reader Smith, Market-place, Kettering.

Tenders, endorsed "Cast Iron Pipes," must reach me not later than Monday, the 17th instant.

JOHN BOND,
Clerk to the Council.

Council Offices, Kettering,
3rd December, 1923. 4270

The Ministry of Public Works, EGYPT, are calling for TENDERS for the SUPPLY and ERECTION of a PUMPING PLANT to replace an existing steam plant at Qassassin. The contract will include the dismantling and removal of the existing plant. Firms quoting must send their Tenders direct to Egypt, where they are due 5th February, 1924.

Forms and specification, price 10s., can be obtained at the office of the INSPECTING ENGINEER, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W. 1. 4302

The South Indian Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY of:—
ONE 40-TON LOCOMOTIVE HOIST.

Specifications and forms of Tender will be available at the Company's Offices, 61, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Locomotive Hoist," must be left with the undersigned not later than Twelve Noon on Friday, the 4th January, 1924.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specification.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

W. B. REYNOLDS,
For Managing Director.

6th December, 1923.
61, Petty France, S.W. 1. 4288

PUBLIC NOTICES

The Great Indian Peninsula Railway Company, 48, Cuthall-avenue, London, E.C. 2, invite TENDERS for:—

		Fee.
1.	POINTS and CROSSINGS, &c.	10s.
2.	FIRE-BRICKS	5s.
3.	BELLOWS	2s. 6d.
4.	STEEL WORK for BRIDGES	10s.
5.	SPARE PARTS of CARRIAGES and WAGONS (BUFFERS) (L.)	£1

Tenders are due by 11 a.m. on 18th December, 1923. Tender forms obtainable at above address. Fees not returnable. 4297

SITUATIONS OPEN

WANTED, a Capable Young ENGINEER of Good address, to Represent an important Firm and Push Sales. Preference given to one who has a good general acquaintance with industrial engineering and some previous experience in interviewing firms to obtain orders.—Address, "ALPHA," Wm. Porteous and Co., Advertising Agents, Glasgow. P8390 A

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WANTED, SALESMAN, with Good Connection amongst steam users to Sell important Feed-water Accessory Plant. Some knowledge of water chemistry and engineering desirable, but applicant must have proved record of success as interviewer and order getter. No others need apply. Salary, commission, and expenses.—Box U.W.S., c/o Hopwood's, 170, Fleet-street, E.C. 4. P8388 A

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CIVIL ENGINEER, Junior, REQUIRED for Contracts in Tropics. Minimum age 25. Sound constitution essential.—Write, Box 118, c/o Dawsons, 17, Craven-street, London, W.C. 2. 4260 A

ENGINEER, ASSISTANT, A.M.I.C.E., with Railway experience, WANTED, for maintenance permanent way, Colonial Railway. Salary £550.—Write, Box 940, Leathwait and Simmons, 34, Threadneedle-street, E.C. 2. P8304 A

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SITUATIONS OPEN (continued)

SECRETARY-CASHIER REQUIRED for Engineering Works near Leeds; must be energetic and have initiative and be able to take charge of correspondence and control staff. Age 30-40.—Address, stating age, experience, and salary required, 4300, The Engineer Office. 4300 A

SALES REPRESENTATIVE REQUIRED in London. Good education and experience combined with technical knowledge of commercial motor vehicles essential. Apply by letter, stating age, experience, and salary expected.—Address, 4288, The Engineer Office. 4288 A

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WANTED, Capable DRAUGHTSMAN for Steam Wagon Design. Must have had good experience in this class of work. State fully age, experience, and salary required.—Address, 4286, The Engineer Office. 4286 A

WANTED, ENGINEER-DRAUGHTSMAN, with experience of Dock and Harbour Work and the preparation of plans for same. Age not over 35. Applicants should state age, salary required, giving particulars of experience and training in surveying and the preparation of drawings.—Address, 4231, The Engineer Office. 4231 A

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Also good GENERAL DRAUGHTSMAN, used to Permanent Way and other Railway Works.

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SITUATIONS OPEN (continued)

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WANTED, 5-TON LOCO. STEAM CRANE, in Good condition. Please state price, makers, age, and where can be inspected.—Address, 4304, The Engineer Office. 4304 F

WANTED, 11 H.P. BLACKSTONE OIL ENGINE.—Address, 4284, The Engineer Office. 4284 F

BAR STRAIGHTENING MACHINE, New or second-hand, electrically driven, to handle up to 6in. round, WANTED IMMEDIATELY.—Send fullest details to P.O. Box No. 31, Sheffield. P8404 F

PHOTO COPIER-ELECTRIC (BLUE PRINTING MACHINE) for 110 volts double elephant size, second-hand; must be in good condition and cheap.—NEWMAN, HENDER and CO., Ltd., Woodchester, Glos. 4296 F

PRESSES.—WANTED to PURCHASE, Several Second-hand Taylor and Challen B. 3 or B. 3½ PRESSES.—Full particulars to G. A. HARVEY and CO. (London), Ltd., Woolwich-road, S.E. 7. 4309 F

5-TON and 3-TON STEAM TRAVELLING CRANES REQUIRED.—Address full details and place of inspection, 4197, The Engineer Office. 4197 F

PATENTS

SAFETY LOCKS.—The OWNERS of BRITISH PATENT No. 127,394, covering "Improvements in Safety Locks," DESIRE to DISPOSE of the PATENT either by SALE outright or by means of LICENCES to work on a royalty basis.—Particulars may be obtained from TECHNICAL RECORDS, Limited, 39, Lincoln's Inn-fields, London, W.C. 2. 4276 H

THE PROPRIETOR of LETTERS PATENT No. 156,008, relating to "METHOD OF MANUFACTURING CHAINS," DESIRES to DISPOSE of his PATENT or to GRANT LICENCES to interested parties on reasonable terms for the purpose of EXPLOITING the same and ensuring its full commercial development and practical working in this country.—Inquiries to be addressed to CRUIKSHANK and FAIRWEATHER, 65-66, Chancery-lane, London, W.C. 2. 4345 H

THE PROPRIETOR of LETTERS PATENT Nos. 127,248, relating to FUEL AND LIKE PUMPS; 127,249, relating to "ATOMISERS FOR LIQUID FUEL ENGINES"; 127,250, relating to "LIQUID FUEL ENGINES"; 127,251, relating to TWO-STROKE LIQUID FUEL ENGINES"; 173,221, relating to "IGNITION DEVICES FOR INTERNAL COMBUSTION ENGINES"; 173,222, relating to "COMBUSTION CHAMBERS FOR INTERNAL COMBUSTION ENGINES"; 173,223, relating to "INTERNAL COMBUSTION ENGINES"; 173,224, relating to "FUEL INJECTING DEVICES FOR INTERNAL COMBUSTION ENGINES"; and 146,495, relating to "TWO-STROKE LIQUID FUEL ENGINES," DESIRES to DISPOSE of his PATENTS or to GRANT LICENCES to interested parties on reasonable terms for the purpose of EXPLOITING the same and ensuring its full commercial development and practical working in this country.—Inquiries to be addressed to CRUIKSHANK AND FAIRWEATHER, 65-66, Chancery-lane, London, W.C. 2. 4286 H

PATENTS.—"IMPROVEMENTS IN FLAX HARVESTING MACHINES."
THE PROPRIETORS of Messrs. Vessot and Pilkey's BRITISH PATENTS Nos. 162,605, 158,322, and 161,134 are DESIROUS of LICENSING these PATENTS to British Manufacturers on reasonable terms to ensure their manufacture and development in Great Britain, or of SELLING the PATENTS outright.—For full information address Inquiries to W. P. THOMPSON and CO., Chartered Patent Agents, 12, Church-street, Liverpool. 4307 H

FOR HIRE

FOR HIRE, PUMPS and WELL-BORING TOOLS for Contractors' Deep Wells, &c., 3in. to 24in. dia.—E. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No., 978 Hop. 8222 K

FOR SALE or HIRE, ELECTRIC MOTORS, from 60 to 500 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms. Immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-street, London, E.C. Tel., City 3028. Ex.

FOR SALE

BALING PRESS, One New Hydraulic, Capacity 240 tons; cost about £4500; offers invited.—The LIQUIDATOR, Scottish Mesopotamia Corporation, Ltd., 31, George-street, Edinburgh. 4262 G

CYLINDER BORING.—FOR SALE at Low Price, a Good DUPLEX HORIZONTAL CYLINDER BORING MACHINE, designed to bore two cylinders simultaneously from 3in. to 18in. diameter; complete with boring bars, overhead gear, &c.—JOHN H. RIDDEL, Ltd., 40, St. Enoch-square, Glasgow. 3040 G

ECONOMIC TYPE BOILER, by Daver-Paxman, 14ft. by 8ft., 6000 lb. evaporation per hour, insured 150 lb. pressure. Complete with all fittings and mountings as fixed. Immediately available. FOR SALE or HIRE.—JOSEPH PUGSLEY and SONS, Ltd., Cattybrook Ironworks, Lawrence-hill, Bristol. 4250 G

ELECTRIC GENERATING PLANT FOR SALE by PRIVATE TREATY.
Power-house Equipment of "Westinghouse" Generating Sets, supplying current at 500 volts D.C. (total 1070 K.W.), including Four 250 H.P. Vertical 3-Cylinder Gas Engines and 180 K.W. Generators. Two 300 H.P. Vertical 6-Cylinder Gas Engines and 625 K.W. Generators, Compressors, Switch and Control Panels, &c.
For further particulars apply, J. GRAHAM TAYLOR, F.A.I., Machinery and Contractors' Auctioneers and Valuer, Ocean Chambers, 44, Waterloo-street, Birmingham. Tel., Central 7433. 4275 G

FOR IMMEDIATE DISPOSAL, TWO Belt-driven Gas Engine GENERATING SETS, comprising two twin-cylinder horizontal Crossley engines, 18½in. bore, 27in. stroke, 180 revs. per minute, suitable for producer or town's gas; two compound generators, 140 K.W., 220 volts, 700 revs. per minute; belts, &c. The above can be seen running by appointment and is on offer at a very low price.
S. J. MORELAND and SONS, Ltd., Match Works, Gloucester. 4312 G

FOR IMMEDIATE SALE, in Good Condition and at low prices:—
Hopkinson-Siemens GENERATING SET, 400 K.W., 250 volts D.C.
200 I.H.P. HORIZONTAL CORLISS MILL ENGINE, belt drive.
Powerful Horizontal Compound Steam-driven HYDRAULIC PUMPS, by Sir Wm. Arrol and Co., Ltd.; capacity 250 gallons per minute.
JOHN H. RIDDEL, Ltd., 40, St. Enoch-square, Glasgow. 3797 G

FOR IMMEDIATE SALE.—
Modern 18in. SLOTTING MACHINE, by Smith and Coventry.
TWENTY B.S.C. LATHES, from 4½ to 16in. centres, hollow spindles, standard makers.
TWO Excellent VERTICAL DRILLING MACHINES.
TWO RADIAL DRILLING MACHINES, 5 and 9ft. arms.
Low prices for immediate clearance.
JOHN H. RIDDEL, Ltd., 40, St. Enoch-square, Glasgow. 3788 G

FOR SALE.—
ONE New 12½in. Centre LATHE, with 10ft. 6in. gap bed, S.S., S.C. and S.A., hollow spindle, 3in. in bore, by Robson, Shipley.
ONE Practically New 4in. SLOTTING MACHINE, by Clarke.
ONE New 12in. SHAPING MACHINE.
ONE No. 5 ARBOR PRESS.
TWO VERTICAL SERVICE PUMPS, by Weir, 5in. steam by 6in. water by 12in. stroke.
ONE VERTICAL BOILER FEED PUMP, 8½in. steam by 9in. water by 12in. stroke.
FIVE New DONKEY PUMPS, 5½in. steam by 3½in. water by 6in. stroke.
TWO New SCREWING MACHINES for pipes up to 3in. bore.
STANLEY ENGINEERING CO., Bath. Ex.

FOR SALE, CAMERON PUMP, with Double 12in. cylinders, 12in. ram, 27,000 gallons per hour. Excellent condition.—JOSEPH PUGSLEY and SONS, Ltd., Lawrence-hill, Bristol. 4256 G

FOR SALE, Owing to Adopting Electricity, 200 H.P. DOUBLE-CYLINDER ENGINE with driving gear (by Brightside Foundry and Engineering Co.); also LANCASHIRE BOILER, 30ft. by 8ft., with forced draught attachment. Can be seen at work.—Apply, DARLINGTON WIRE MILLS, Ltd., Darlington. 4292 G

For continuation of For Sale Advertisements see page 3

A Seven-Day Journal

Proposed Italian Selling Organisation.

IN our issue of November 2nd we briefly announced that a number of well-known firms had under consideration a scheme for forming an organisation for selling engineering and allied products in Italy on a co-operative basis. We have now received from the Selson Engineering Company, Limited, of London, further particulars regarding the scheme, from which we gather that membership of the proposed British-Italian Direct Engineers' Representation Association is to be confined to non-competing British engineering and allied firms, and that each member would be required to subscribe £20 towards the capital of a small Italian limited liability company, to be established as the Association's trading organisation in Italy and its colonies. This Italian company would take over the existing organisation of the Stabilimenti Selson at present under the management of Mr. W. E. Jackson. The Selson Engineering Company would act as the London office of the Italian company, directing its management—subject to the Association's executive committee—arranging matters connected with the placing, shipping, and delivery of orders, and generally assisting members in their dealings with Italy. For these services the Selson Company would receive a small commission on the members' turnover in Italy, not exceeding 2½ per cent. Towards the working expenses of the Italian company each member of the Association would in the first year contribute £25 per month and in subsequent years a sum to be decided by the board, but not exceeding £300 annually. The Italian company would receive a commission of from 2½ to 10 per cent. on the orders placed through its agency, the profits so realised being placed to the benefit of the members of the Association. It is claimed that by means of this scheme the members, for a very modest cost, would secure the benefits of a branch organisation in Italy which is already very well known, possesses long experience of Italian business, and has fully equipped show-rooms and warehouse accommodation in Turin.

The Director of Naval Construction.

IT is announced that Sir Eustace Henry William Tennyson-D'Eyncourt is retiring at the end of the year from the post of Director of Naval Construction and Chief Technical Adviser to the Admiralty, and that he is returning to Sir W. G. Armstrong, Whitworth and Co.'s service at the Elswick Works. Sir Eustace succeeded Sir Philip Watts when he retired in the summer of 1912. He served his apprenticeship at Elswick. From 1898 to 1902 he acted as naval architect and chief designer at Fairfield and acquired much experience on the construction of liners. In the latter named year he returned to Elswick as naval architect under Mr. J. R. Perrett, which post he continued to hold until in 1912 he was appointed to the Admiralty. In his official capacity he was responsible for the designs of the "Royal Sovereign" class, of the Hood and of the new warships and cruisers. In addition, he was intimately connected with the construction of the numerous auxiliary vessels built during the war and also played an important part in the evolution of the tanks. It may be noted that Sir William White, 1885, Sir Philip Watts, 1902, and Sir Eustace Tennyson-D'Eyncourt, 1912, formed an unbroken succession of Directors of Naval Construction, who were selected by the Admiralty from the staff of the Elswick Works.

The Sheffield Pit Disaster.

THE accident which occurred on Monday at the Nunnery Colliery Company's pit at Sheffield—the third mining disaster of the year—is of a kind which is now, fortunately, of comparative rarity. While a train of about forty tubs, carrying some 130 men of the afternoon shift, was being run down the engine plane, the rope suddenly broke. The train ran away, and after proceeding several hundred yards with rapidly increasing speed, became derailed. In the ensuing smash, seven men were killed and forty-six injured. The pit is one of the largest in the South Yorkshire coalfield, producing about 700,000 tons per year. The incline on which the accident happened is a steep one, running from the foot of the pit towards the working places. We gather that the train of tubs had been stopped for a moment on the incline to permit the passage of a party of men across it, and that the rope broke almost immediately after the train was restarted.

Improved Tramway Cars.

WHILE the London County Council is about to abandon the use of trailer cars on its tramway system, as noted in a succeding paragraph, another tramway undertaking in the Metropolis—the Metropolitan Electric Tramways—is interesting itself in the question of car design and its effect upon the efficiency of operation. Some time ago, this same company, if we recollect aright, was conducting experiments with a system of construction designed to dispense with the necessity for the services of a conductor, but we are not aware whether the results arrived at were satisfactory. We now learn that the company is at present carrying out trials with a car provided with reversible staircases on a system devised by a member of its staff. At a terminus, the conductor turns one of the staircases round, so that both lead from the near side of the car to the top deck. The idea is that while one end of the car should be used by passengers alighting at any point of the journey, the other should be used by would-be passengers boarding the car. In this way, it is thought, a considerable saving of lost time would be effected.

Trailer Cars on the L.C.C. System.

AT Tuesday's meeting of the London County Council the Highways Committee submitted a recommendation urging that as soon as equivalent accommodation on tractor cars could be provided the use of trailer cars on the Council's system should be abandoned. Trailer cars were first used in London in connection with single-deck cars running through the tramway subway below Kingsway. Their employment was gradually extended until they were to be found running on many of the routes south of the Thames, attached to high-powered double-deck cars. In 1922 the Wimbledon Corporation refused to allow trailers to be employed on the Merton and Wimbledon tramway, then newly acquired by the County Council. As a result of that refusal steps were taken to investigate the benefits or otherwise of trailers. Two different series of observations, each over two periods of six days, showed that more passengers could be carried by means of single-unit tractor cars than by means of tractor and trailer combinations, that the former were cheaper to operate and quicker, and that trailers were responsible for considerable delay to single-unit cars using the same or part of the same route. Following these observations, trailers were provisionally withdrawn from all the routes on which they were being operated except one, and it is now proposed to follow suit on the exception.

The Trans-Saharan Railway.

THE project for the construction of a railway between North Africa and the Niger Valley has been the subject of so much discussion in France, and appeared to offer so little chance of taking practical shape in view of the conflicting claims of the three or four proposals presented and of the technical difficulties involved, that the decision of the French Government to proceed at once with the construction of a line has taken everybody by surprise. The reason for this sudden decision is the necessity for carrying out the conditions of the recruiting law, providing for the calling up every year of 280,000 natives, chiefly from Africa. If this native force is to be available for home defence, it follows that means must be found of recruiting the men and bringing them rapidly to an African port, at which they can be embarked for transport to France. For this purpose Oran has been selected as the port, and a normal gauge railway will pass from Algeria through the western part of Morocco and then to Kenatsa, where coal deposits have recently been found. After following the Saoura *oued*, the line will connect up the series of oases of Touat, whence it will traverse the desert region of Tanezrouft until it reaches the wells of Tessalit. The railway will join the Niger at Tosaye, and will have its terminus at Ugadugu. At that point it will join the railway system which it is proposed to construct under the Sarraut scheme. The line has been surveyed for most of the distance, and little remains to do now but to work out the details and shorten the route as much as possible. The selection of the toute indicated has been influenced mainly by two considerations; that is to say, the necessity of keeping at a safe distance from the Atlantic coast and from the regions that are not entirely under subjection, and of profiting from a development of traffic in the more fertile parts of West Africa. On account of the difficulty of procuring water, the railways will be worked by petrol locomotives.

Locomotive Running Repairs.

A VERY interesting paper entitled "Railways of To-day and To-morrow, with Special Reference to Operating Aspects," was read by Mr. C. Travis at the Institute of Transport on Monday. As its title conveys, it was mainly concerned with the operating—what used to be called the traffic—side of railway working and dealt with a situation which was well summed up in the words: "The position is such that the railway companies, with enormous burdens to bear, and with the obligation under the Act to ensure effective working in order to retain their right to the standard return, will be compelled to investigate their methods closely and regularly to ensure that every available opportunity is taken of reducing the cost of working." Except in a general way there was little in the paper that affected engineers alone. One point, however, attracted our attention, and this was the plea that locomotive running should be a function of the operating department. The paper observed that "issue will, however, be joined on the question of running repairs; there is much to be said on both sides, but the balance of evidence would appear to show that this item should also become a responsibility of the properly qualified officer attached to the operating chief for this duty." This suggestion will meet with a mixed reception. Divided responsibility is to be feared. On the whole, it seems advisable to leave the repairs with the locomotive department, even at the risk of engines being put out of service for some trifling defect at a time when power is greatly needed.

Synthetic Ammonia.

WE learn that the development work which the Synthetic Ammonia and Nitrates Company—an undertaking formed in 1920, as a subsidiary of Brunner, Mond and Co.—has been conducting, has now reached fruition, and that the production of synthetic ammonia by the Haber process will soon be an accomplished fact in this country on a commercial scale. It will be recalled that shortly before the Armistice, the Government decided to establish synthetic ammonia works at Billingham, near Stockton-on-Tees, and that, on the conclusion of peace, negotiations were begun, which led to the site being taken over by Messrs. Brunner, Mond. In preparation for the establishment and operation of the works, large-scale experiments were begun in 1922 at the Castner-Kellner works at Weston Point, Cheshire, a site selected because the manufacture of electrolytic caustic soda there carried on yields the supply of hydrogen which the Haber process requires. These experiments, it is gathered, have proved remarkably successful, and plans for the Billingham works are now being completed. It is expected that the first unit for the production of ammonium sulphate will shortly be completed.

Dumping High Explosives at Sea.

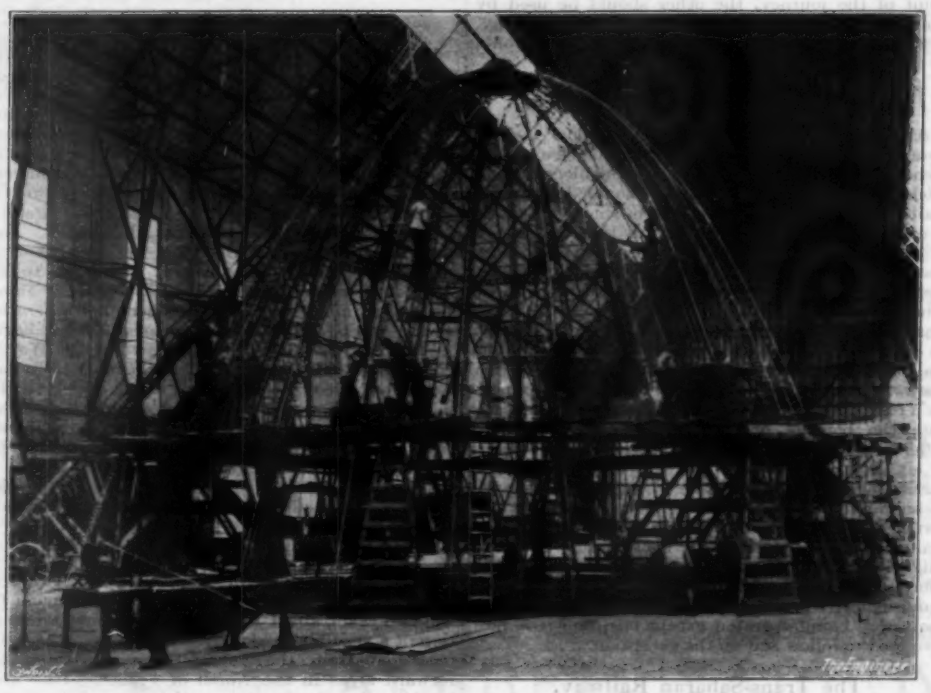
THROUGH the Port of Dunkirk there has been dumped in the sea about 2½ miles away, during the last two years, about 14,000 tons of German ammunition of a very highly dangerous character, which was recovered from the devastated regions and the forward areas in the North of France. This work has been done to the entire satisfaction of the French military and naval authorities by a local firm at Dunkirk, namely, the Maison Victor Rose, acting in conjunction with Mr. F. N. Pickett's firm. Not one unfortunate incident or accident has arisen either in the dumping operations at sea or in the transport of the material by rail from the different factories. This fact is said to be unique in dealing with such material left over from the war. The scheme of dealing with the material was conceived by Mr. Pickett and his general manager in France, Mr. Suggett, in conjunction with Major M'Kenna of the Disposals and Liquidation Commission, and the French military authorities. It would, of course, have been impossible to have accomplished this feat without the cordial assistance of the officers of the Chemin de fer du Nord. Mr. Pickett's firm, it may be recalled, secured a large contract for breaking down and disposing of the shells left in France. That contract, we understand, has now practically been completed.

The National Air Company.

IT is stated, unofficially, that the Treasury, within the last few days, has signed a contract with the British, Foreign and Colonial Corporation for the formation of the National Air Company on the lines laid down by the Committee on Air Subsidies. It will be recalled that Sir Herbert Hambling's Committee suggested that the proposed Air Company should have a capital of £1,000,000, the Government guaranteeing the payment of 10 per cent. per annum on the paid-up capital for ten years, or until such time as the company became self-supporting. The Committee was very insistent in its view that the company should not be created by any simple amalgamation of the undertakings at present operating air services in this country. It would appear that in the formation of the company this requirement has been given effect to, for although the Instone, Daimler and Handley Page air transport companies will all have representatives on the board, others outside these undertakings will also be associated with it. Sir Eric Geddes, it is stated, will be the chairman of the new company, while among the directors will be Lord Invernairn, chairman of William Beardmore and Co., Limited; Sir J. G. Beharrell, of the Ministry of Transport; and Sir Herbert Hambling, deputy chairman of Barclay's Bank. The new company will, it is understood, continue to operate the existing air services, but will extend the London-Paris service to Zurich, the London-Cologne service in the direction of Constantinople, the London-Amsterdam service to Berlin as a regular feature, and the Southampton-Channel Islands service to Cherbourg. Inland, the London-Manchester service will probably be resumed, and a regular Plymouth to Belfast service will, in all likelihood, be established, following the success of the experiments conducted two months or so ago in connection with the rapid distribution of the North Country and Irish mails arriving at Plymouth on the Trans-atlantic liners.

The Zeppelin Passenger Airship LZ. 126.

The airship LZ. 126, which is now quickly approaching the stage of completion in the works of the Zeppelin Company at Friedrichshafen, was ordered by the German Government on its own account in 1922, but is destined to be handed over to the United States by way of reparations payment. During the past twenty-five years the Zeppelin Company has constructed 126 airships, 25 before, 88 during, and 13 since the war.



BOW END OF FRAMEWORK BEING ERECTED

A decisive factor determining the size of this latest product of the company was the limitation imposed by the Allies that it was not to be larger than the largest Zeppelin built during the war. The general lines of the design are as a consequence similar to those of the last war-time production, the details being, however, modified in the light of the experience gained with the passenger airships Bodensee and Nordstern, built since 1918. The gas capacity of the vessel was thus fixed at about 70,000 cubic metres, its overall length at 200 m., its maximum diameter at 27.64 m., and its greatest vertical dimension, taken as including the gondola buffer, at about 31 m. As a second condition the Allies required that the vessel should not be used for war purposes, but only for the development of airship services in America. Provision for offensive and defensive equipment was therefore omitted, and instead accommodation was arranged for twenty passengers.

The body of the airship consists of a skeleton of aluminium alloy* girders braced with steel wire tension members and covered with a skin of proofed cotton material. The skeleton girders are arranged in the form of a series of 24-sided rings joined by longitudinals. The rings are regular figures except at the lowest point, which is carried down to an extent which results in the two ring segments on either side of it becoming collinear and two of the twenty-four corners disappearing. At the stern, as shown in the engravings given in our two-page Supplement, the section changes to an octagonal form. The rings are of two kinds, braced and unbraced. As shown in the photographs reproduced on page 616, the braced rings occur at the bulkheads which divide the gas space into cells, while the unbraced occur intermediately. The unbraced rings are spaced 5 m. apart, while the braced rings are separated by 15 m., except at the stern, where the spacing is 10 m. for the two last sections, and at the bow, where the first section has a length of 11 m.

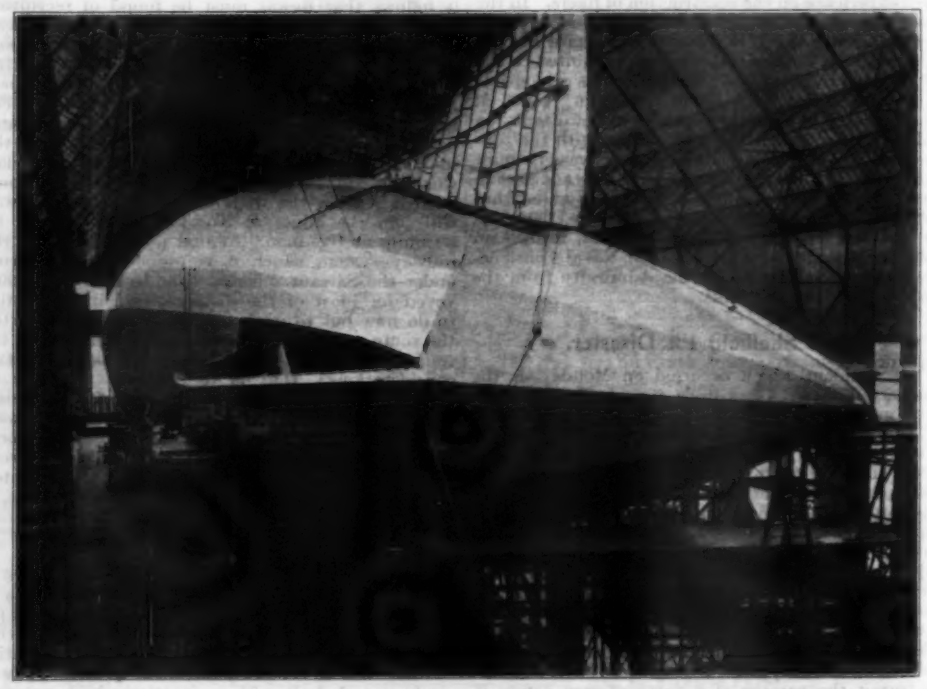
Each girder in the framework consists of three longitudinal members of drawn sectional material united by crossed lattice strips pressed out with flattened ends and channel sectioned bodies. The strips are fastened to the longitudinals by means of two rivets at each end and are united to one another at the point of crossing by means of four rivets. The twenty-four corners of the main and intermediate rings are connected by the longitudinal girders which run the full length of the hull. These longitudinal girders are built up on the same principle as the ring girders, the only difference being that, whereas in the rings the girders are disposed with an apex of the triangular section pointing inwards, in the longitudinal girders one of the apices points outwards. The main rings are braced with steel wire and steel rope, which, as indicated in one of the views on page 616, press against and support the flat bulkhead surfaces of the gas cells. The rectangular panels formed by the ring and longitudinal girders are also braced by diagonal wiring and are, in addition, filled in with a network of ramie cord for the support of the fabric covering and the cells. On the underside the hull is strengthened by a central girder system—see the first view on page 616—which not only serves to distribute the load, but provides a means of access to all parts of the ship and in particular to the spaces between the gas cells, in which spaces the various pipes, cables, and ropes required for the control and navigation of the vessel are disposed. The cross section of the central girder system is pentagonal, the top side being horizontal and the two lower sides being formed by the two lowest girders of the rings. The pentagonal section is subdivided by diagonal girders into triangular areas. At the ends of the hull the pentagonal section changes to a triangular one. In its upper portion the passage-way thus formed is contained within the gas space and is there bounded by the walls of the cells. In the lower portion it projects outside the body with the form of a wedge section. At the front end the framing is specially strengthened in order to meet the desire of the American authorities that the vessel shall be capable of being anchored to a mooring mast. At the stern the horizontal and vertical fins are formed on frameworks of girders. Internally the framework of the hull is reinforced by a system of cross girders between the two last main rings for the purpose of supporting the fin surfaces.

The hull, the keel passage, and the fins are covered with cotton fabric, which varies in thickness according to the strength required to meet the varying loading at different places. The fabric selvedges are reinforced with bands stitched on to them, into which bands are inserted the eyes for the lacing cords. The latter cords are of ramie fibre prepared by a process designed to take account of the stretching of the fabric covering, the correct loading of the framework girders and the temperature and humidity of the atmosphere existing at the time when the covering is applied and laced up. The fabric covering is proofed several times in order to give it as smooth a surface as possible, and the proofing solution has mixed with it a proportion of aluminium powder so as to give the finished surface a dull mirror-like appearance. The gas cells in the interior of the hull are formed of cotton fabric and gold-beaters' skin, the first named giving the necessary strength and the second the necessary gas-tightness.

The passengers' and commander's gondola is attached to the underside of the hull framework near the bow. It is built up on a framework of triangular and rectangular sectioned girders, of which a view taken before the gondola was attached to the hull is reproduced on page 605. The five motor gondolas are of stream-line form, and are formed of rolled sectional material and metal plating. The engine foundations are built of sectional material and girders, on which are supported the thrust and propeller bearings. The foundations are attached to the hull framework by a structure composed of flattened tubes. The radiators are built into the forward part of the gondolas, and the air passing through them is controlled by means of specially designed nozzle type throttle valves. The upper portions of the gondolas are covered with fabric. Ladders are provided from the gondolas to the ship, and are so designed that they may be folded, rail to rail, in which condition they assume the form and function of stream-line stays. The openings giving access to the gondolas can be closed by means of sliding panels, both in the ship hull and in the gondolas themselves.

A new type of engine has been specially constructed for this airship. It is of the Maybach airship pattern, and is designed to develop 400 brake horse-power at 1400 revolutions per minute. The engine is reversible, and both the reversing and the starting gears are operated by compressed air. In general, the design differs widely from that of any previous aero-engine. The conditions demanded of the power equipment are long life, trustworthiness and simplicity of installation. In addition, the permissible interval of time between inspections and overhauls had to be as long as possible. To meet these requirements, an all-round heavier engine than previously used was indicated. The speed was fixed at 1400 revolutions, because such speed was held to be the most economical one for a direct-driven propeller. Had gearing been used, there would have been a considerable increase in the total power equipment weight.

The crank shaft is completely housed in the upper



STERN VIEW SHOWING CONTROLLING ORGANS

* "Duralumin" in the German original from which this article has been prepared; but as that word represents a proprietary article in this country and as the German alloy corresponding to it is said to be definitely different from the British-made material, we prefer to use the expression "aluminium alloy."—Ed. The E.

part of the crank case. All the main bearings are of the roller type—a form held to give trustworthy service and practically unlimited life of the bearing. The cylinders, twelve in number, are arranged in vee-form. Between the two rows the cam shaft and valve operating gear are arranged. The cylinder blocks are made of grey cast iron with the water jackets welded on. The cylinder heads are so designed that equal cooling is given to all parts. Each cylinder is provided with one large inlet valve, two smaller exhaust valves and two sparking plugs. As usual, the valves are operated by means of push rods. The cam shaft is driven by gearing from the crank shaft, the same drive serving to operate the auxiliaries. Four carburetters of the latest Maybach pattern are arranged between the two rows of cylinders. The exhaust pipes are carried along the outside of each row of cylinders.

Each motor is equipped with two twelve-cylinder Bosch magnetos, driven through an elastic coupling in order to avoid vibration. The ignition apparatus is arranged to work in either direction of rotation without alteration. Control of the ignition is secured by rotation of the driving shaft, the arrangement being such that the intensity of the spark is the same for all positions. The circulating water pump delivers equal volumes of water for both directions of rotation. Lubrication is effected by means of one circulating and two suction pumps, the drives to which are such that the direction of working of the pumps is not altered by the reversal of the motor. The oil is withdrawn from the casing by the suction pumps at two points, and is then circulated through a filter to the main and other bearings.

When the engine is being started air from a receiver is admitted through a distribution system, and caused to enter each cylinder at the correct instant. Starting valves, operated by the compressed air supply, are provided on each cylinder, and are shut down automatically as soon as the engine picks up on the ignition. It is claimed that although very little air is used the turning moment created at starting is large. The reversal of the direction of rotation is effected by sliding the cam shaft. A two-stage air compressor provides the starting air, and can be coupled to or uncoupled from the engine crank shaft while the engine is running. It is claimed that it is impossible to start the engine in a wrong manner, as the starting levers, the throttle, and reversing levers, and the ignition control are interlocked in such a way that they can be operated only in the correct direction. The interlocking arrangements render it impossible to start the engine otherwise than in the direction fixed by the position of the cam shaft. In addition, they are such that the ignition control is always set correctly for the direction in which the engine is to run. It is, moreover, impossible to reverse the engine if the throttle lever is not in the neutral position, and before the throttle lever can be moved the reversing lever must be in one or other of its end positions. Over and above these safety arrangements, the engine is fitted with an automatic device, whereby it is brought to rest immediately the lubricating oil pressure falls below a given value.

The propeller is coupled directly to the motor, except for the interposition of an elastic coupling built into the fly-wheel and a dog clutch. The propeller has a diameter of 3.7 m., and is built up of glued laminæ. A protecting strip of aluminium is attached along the edges.

The fuel storage details include petrol and lubricating oil tanks, which for the main part are disposed as shown in one of the accompanying engravings within the central corridor in the keel. The petrol tanks are divided into working and storage tanks, the former being carried at a higher level than the motors, in order that the feed may be effected by gravity. There are three such working tanks at ring 60 and six each at rings 85 and 115. Each working tank has a capacity of 440 litres. The storage tanks hold 420 litres, and carry all told over 17 tons of fuel. They are placed at convenient points in the central corridor, and by means of a pump and pipe system their contents can be transferred to the working tanks. Some of the storage tanks are slung so that they may be dropped and others can, if necessary, be removed and replaced by water ballast containers. For the journey across the Atlantic thirty additional tanks are being provided. Each motor gondola has a service tank holding 95 litres of lubricating oil, while in the central corridor there are five storage tanks of 420 litres capacity each. All the fuel and oil tanks are made of sheet aluminium.

The airship is provided with two rudders and two elevators, each with an area of 17 to 19 square metres. The rudders and elevators are controlled from the commander's gondola through a system of steering wheels, chains, cables and quadrants. The elevators areof the balanced type, with triangular compensating areas.

All the gas cells, with the exception of that at the stern, which is in communication with its immediate neighbour, are fitted with 500 mm. safety valves, the largest cells being fitted with two such valves each. The gas discharged from these valves finds its way through free passages between the cells to an upper air space between the cells and the covering, which space is kept ventilated by means of seven cowls formed in the hull. Eight of the cells are, in addition, provided with manœuvring valves which can be controlled from the commander's cabin.

The ballast provided consists of water treated so as to lower the freezing point and is carried in rubber receptacles in the central corridor. Six of the receptacles, each containing 250 kilos. of water, are disposed at the bow and stern and can be quickly emptied in order to trim the vessel when landing. Fourteen additional receptacles, each holding 1000 kilos., are distributed intermediately in the corridor. The water ballast valves are controlled by wire ropes from the commander's cabin. The vessel is provided with a wireless equipment on the Telefunken system, which is served by a windmill and dynamo which can be swung in or out from the hull. A similar arrangement provides current for electric lighting, in connection with which accumulators are also provided. A loud-speaking telephone provides communication between the commander's cabin and the lookout platform.

The accommodation for the officers and crew consists of (*a*) a cabin for the commander provided with a bed, table, chair and cupboard; (*b*) two sleeping cabins for the officers, each with two beds and two chairs; (*c*) an officers' saloon with a table and seating accommodation; (*d*) six sleeping cabins for the crew, each containing two beds and two seats; (*e*) two saloons for the crew, each with a table and seating accommodation; (*f*) two sets of lavatory and water-closet fittings. The whole of this accommodation is arranged along the sides of the central corridor.

The passengers are provided with accommodation in the main gondola behind the commander's cabin. The passengers' cabins are five in number and are fitted up after the manner of a Pullman sleeping car. Each cabin contains four beds arranged transversely in two tiers and capable of being separated by curtains. By day the upper bed in each tier is folded down and serves as a settee back for a seat constituted by the lower bed. When desired, a table may be placed between the seats. Each cabin is provided with a large window in three sections, and with a wooden flooring covered with felt. On the port side behind the passengers' cabins lavatory and water-closet accommodation is arranged, while opposite on the starboard side is the entrance passage and the kitchen. During a voyage the entrance passage serves as the steward's room. The kitchen is lined with aluminium on the walls, ceiling, and floor. All the cooking is performed electrically. Accommodation for luggage, mails, and cargo is provided in twenty compartments arranged along the length of the central corridor. In addition, there are here also enclosed and locked compartments for provisions, drinking water, and spare parts.

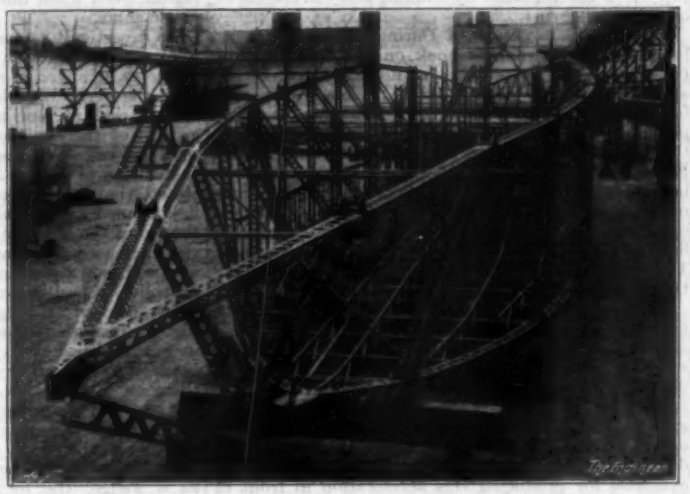
The following particulars relating to the weight of the ship and its carrying capacity are based on the assumptions that the barometer is standing at 760 mm., that the air and gas temperature is 0 deg. Cent., that the air has a relative humidity of 60 per cent., and that the vessel is charged with 70,000 cubic metres of hydrogen having a specific gravity of 0.1 relatively to air.

Total lifting effort (subtracting the gas weight)	81,300 kilos.
Gross weight	41,300 kilos.
Guaranteed useful lift*	41,000 kilos.
Speed at full power	122 kiloms. per hour
Normal service speed, five engines	108 kiloms. per hour
Speed, four engines	100 kiloms per hour
Speed, three engines	90 kiloms. per hour
Radius of action, five engines at full power	46 hours = 5500 kiloms.
Radius of action at cruising speed	78 hours = 8400 kiloms.

(Calculated for a still day and for the condition that there shall be sufficient fuel left at the end of the trip for an additional two hours' running.)

* We give this figure as it appears in the German original, but are unable to account for the discrepancy of 1000 kilos. which it indicates.—ED. THE E.

SOME OF THE FUEL TANKS



FRAMEWORK OF PASSENGERS' GONDOLA

If the airship be used for the carriage of mails, then, allowing for 10 tons of mails, eight passengers, a postal official, and a fuel reserve of 30 per cent. for head winds, it would have a radius of action of 5300 kiloms. at a cruising speed of 108 kiloms. per hour.

Experimental Researches on Propeller Cavitation.

No. II.*

THE term cavitation was first employed by Mr. R. E. Froude some thirty years ago to describe the hollowing-out of vacuous spaces in the region of the blades by the action of the screw, and though a number of experimental researches have been conducted at various times in an endeavour to throw further light upon this phenomenon, the cynically-inclined may not unjustly remark that the vast majority of experiments on cavitation have been made not intentionally on models but accidentally on a scale of 12in. to the foot. The historic instance which first drew attention to the fact that lack of area of propeller blades might result in failure to obtain the designed speed of ship occurred, as is well known, in the case of the 27-knot torpedo-boat destroyer Daring in 1894, and it was from the extensive series of trials with propellers of different proportions which had to be made before the intended speed was eventually obtained that the Barnaby pressure theory of cavitation was first evolved. It so happened that, in the case of the first propellers fitted, the failure to reach the hoped-for speed was a particularly egregious one, and had it not been for this fact, had the speed only been short by perhaps half a knot or so, it is very probable that the true cause would not have been located quite so readily. As it was, the first set of propellers failed to produce a speed of more than 24 knots, or no less than 3 knots below the designed amount, and their performance about this point was characterised by excessive slip and vibration. These screws had the same developed area ratio as those of the earlier torpedo gunboats, which immediately preceded the 27-knot torpedo-boat destroyer class, the blades being of elliptical form with the minor axis of the ellipse equal to $^4/_{10}$ of the major axis, which latter was equal to the half diameter of the screw. Trouble was experienced in obtaining satisfactory speeds with nearly all the

* No. I. appeared November 30th.

torpedo gunboats, and though poor underwater form and frequent mechanical troubles were largely to blame, there can be no doubt that lack of blade area was also very largely responsible for poor speed results in their case also. Unfortunately, they were all out of the builder's hands by the time that the Daring's trouble arose; but fifteen years later, when many of them were re-engined with more powerful machinery, an increase of blade surface out of all proportion to the extra power was provided, and materially better results were obtained.

The trials of the Daring were far from constituting a solitary instance among the earlier experiences of cavitation. Between 1895 and 1900 the British Admiralty laid down over forty vessels of the 27-knot type and over eighty of the 6000 indicated horse-power 30-knot class, and failures to obtain the designed speed owing to unsuitable propeller proportions were at first very common. As in the Daring, diameter and pitch of screw were usually accurately selected at the start, the defect lying in shortage of area, and though no such subsequent instance occurred of quite such an acute effect as was found in the Daring, the difficulties in obtaining the last half knot were generally only overcome by increase in blade area. In all cases where failure occurred from lack of it, there was a sharp rise in the slip curve accompanied by a falling away in the curve of indicated thrust.

Very complete details of Daring's trials are to be found in Mr. Barnaby's book on the "Screw Propeller," but as we propose to indicate later certain apparently rather glaring defects in his theory, the following brief explanation of "cavitation," as propounded by Messrs. Thornycroft and Barnaby in their famous paper read at the Institution of Civil Engineers in 1895, is extracted therefrom. It will be seen later that subsequent theories and still more recent experience have rather run counter to this original view, although Mr. Barnaby himself adheres firmly to it in his last edition published two years ago. The authors of the 1895 paper originally stated their theory as follows:—

"The greater part of the acceleration of the screw race is produced by negative pressure on the forward side of the blades. If the whole of the thrust of the screw be divided into two parts, one part due to negative pressure on the forward side and the other to positive pressure on the after side, the negative exceeds the positive in all cases except the limiting one in which no rotation is given to the race, a condition in which they become equal. The only force available for producing this acceleration in front of the screw is gravity. The recession of the helical surface as it revolves relieves pressure of the water on its forward face, and the water can only follow it up with the velocity which is due to the head above it. At the very small depth below the surface at which the screws work in the Daring, a few inches only, the weight of water over them may almost be neglected, and the head be taken as that due to the pressure of the atmosphere. Fifteen pounds per square inch is, therefore, the maximum which can be obtained from the acceleration produced by atmospheric pressure close to the surface of the water. If the surface is broken and air admitted, the velocity which can be imparted to the water in advance of the screw is very small indeed, being limited to the head of water above it. . . ." This portion of the theory is indisputable. In Mr. Barnaby's book he pointed out that "the point at which the first indication of failure occurs is not marked by a sudden change but by a flexure in the slip curve which commences to rise rapidly after a critical speed has been passed. The total thrust of the screw at which a change manifested itself in the character of the slip curve divided by its projected area, gave a thrust of 11.25 lb. per square inch which is, therefore, about the maximum thrust which can be obtained from a screw working efficiently at a depth below the surface of 11in. which was the immersion of the tips of the screw blades of the Daring. This figure may vary slightly . . . it was obtained with elliptical blades. A higher thrust might be safe with blades which are broad at the tip . . . or with those of finer pitch ratio. . . . For every additional foot of immersion the total thrust per square inch may be increased by three-eighths of a pound." This portion of the deductions from the trials is open to some question. From hydraulic considerations, of course, the increase of pressure due to depth is 0.445 lb.

In the discussion which followed Mr. Barnaby's paper to the Institution of Naval Architects in 1897, Mr. D. W. Taylor asked how cavitation affected efficiency, as it would appear that as soon as a cavity was formed the friction on the back of the blade would be greatly relieved, and it might appear that this fact would tend to minimise the loss. The explanation proferred was that "the screw commences to race as soon as a cavity is formed . . . and the waste of power from the increased slip resulting from the racing is much more than can be compensated for by the reduction in surface friction at the back of the blade."

Of all the original research work undertaken by Sir Charles Parsons in the development of his numerous inventions, none perhaps has exceeded in importance, and certainly none in interest, his investigation and subsequent illustration of the phenomenon of cavitation. It would indeed be difficult to exaggerate the influence which this action exerted on the design of ships and propelling machinery prior to the advent of the geared turbine, which enabled a reversion to original propeller proportions to be made, and as his optical proofs of the appearance of cavitation from its inception up to an extreme phase of development were then absolutely unique in the study of screw propulsion, Sir Charles Parsons' explanation of cavitation demands particular consideration. Before the trials of the Daring, which first drew attention to this difficulty, had taken place, the original Turbinia had been designed with the idea of testing the application of the compound steam turbine for purposes of marine propulsion. This little vessel was originally fitted with a single turbine designed to develop about 1500 horse-power at 2500 revolutions per minute. A single 2-bladed propeller, 30in. in diameter and 27in. pitch, was provided, and with this and a subsequent series of single screws, cavitation was experienced to a very serious extent. So much was this the case that, in Sir Charles' own words, "the advent of the marine steam turbine was greatly delayed, if not almost frustrated at its very inception, by difficulties due to cavitation in its most aggravated form." Trials with a torsional dynamometer conclusively proved that a great loss of power was taking place in the propeller region, even when multiple screws were fitted to the single shaft.

To investigate the nature of this loss, experiments were carried out with model 2-bladed screws of 2in. diameter arranged in a closed tank in such a manner that the screw was kept illuminated at one point only of each revolution, so that the shape, form and growth of the cavities it produced could be clearly seen and traced as if stationary. In his paper to the Institution of Naval Architects in 1897, Sir Charles stated that "it appeared that a cavity or blister first formed a little behind the leading edge and near the tip of the blade; then, as the speed of revolution was increased, it enlarged in all directions until, at a speed corresponding to that of the Turbinia's propeller, it had grown so as to cover a sector of the screw disc of 90 deg. When the speed was still further increased, the screw, as a whole, revolved in a cylindrical cavity from one end of which the blades scraped off layers of solid water, delivering them on to the other. In this extreme case nearly the whole of the energy of the screw was expended in maintaining this vacuous space. It also appeared that, when the cavity had grown to be a little longer than the width of the blade, the leading edge acted as a wedge, the forward side of the edge giving negative thrust."

These test propellers were worked by means of a weight and clockwork wheel train, with a delicate spring balance to register the thrust, and it was found that when the blades of the propeller were broadened so that the projected blade area reached about 0.7 of the disc area, the falling off of the thrust was very small, even in boiling water, while with a propeller of projected area equal to only 0.25 of the disc area the thrust fell to a small fraction under the same conditions.

These trials were carried out in water heated to within a few degrees of boiling point, the idea being to obtain an increased vapour pressure from the water so as to enable actual conditions and forces at work in the real screw to be represented with a more moderate speed than would otherwise have been necessary. Another tank was afterwards constructed in which similar trials were made, but in this case the air was withdrawn by means of a pump so that only the cohesion of the water and the head above the propeller remained to prevent cavitation. Much better observations could be made with this tank.

Contrasted with the Barnaby theory, Sir Charles Parsons' deductions from these experiments demand close attention, the more so, perhaps, in view of subsequent theories which have been put forward. His view was then—1897—"that in all screws, of whatever slip ratio, there will be a limiting speed of blade, depending upon the slip ratio and the curvature of the back—in other words, on the slip ratio and thickness of blade; beyond this speed a great loss of power will occur, and that, should the speed of ships be still further increased, the adoption of somewhat larger pitch ratios than those at present used will be found desirable. . . . As regards the losses of power by cavitation, the effect is felt in the real ship, not in the racing of the screw, but in the loss of propulsion effect. In the model experiments in hot water, the effect was both loss of propulsion effect and also racing, as would naturally be expected from the fact of greater vapour density in the latter case rendering the cavities more stable. . . . It would also seem that the limitation imposed on slip ratio tends in favour of larger pitch ratios for very fast vessels."

The unstable nature of the phenomenon of cavitation was clearly indicated in the vacuum tank. There appeared to be a continual formation increasing in size followed by the rupture of the cavity after a certain limit had been reached, the process being repeated indefinitely. Part of this may have been due to the pulsations of the air pump causing the head to fluctuate, but there seems to be no doubt whatever that the instability which occurs in the tank is precisely what occurs in the case of full-size propellers, and this continued action would seem to have an important influence on the question of the erosion of propeller blades which subsequently became such a serious problem. A larger tank in which more elaborate experiments could be made was afterwards constructed, and Sir Charles Parsons told the Institution of Naval Architects in 1917 that "as before, the spiral vortices generated at the tips of the blades were seen to endure for several convolutions before they disappeared. These seemed to be caused by the flow of water over the blade tips from the pressure to the suction side of the blades. In order to determine the loss involved in the formation of these spirals, little angle pieces were soldered on to the tip of a 12in. diameter propeller about 1in. from the tip and about 1¼in. high, constituting portions of a cylinder the axis of which was coincident with the shaft. This prevented the formation of spirals, but it was found that the skin friction of the angles caused more loss than the generation of the spirals, showing the loss by the latter to be very small in quantity." It is difficult to accept the last part of this statement. A full size screw with blade projections of this nature would absorb a very considerable quantity of power in useless skin friction.

It was as a result of the early trials in the original tank that the machinery arrangement of the Turbinia was modified, and, in lieu of a single shaft, she was fitted with three turbines, H.P., M.P. and L.P., arranged in series on three separate shafts. Each shaft was fitted with three 18in. propellers of unity pitch ratio, making nine in all, and these were eventually superseded by others, designed as the outcome of these experiments, of the same diameter but 24in. pitch, the ratio of projected to disc area being 0.46. This subdivision of power resulted in an extraordinary increase of propeller efficiency and speed, the latter eventually reaching 32¾ knots as against 19¾, with the original single shaft and three propellers 20in., 22in. and 22in. diameter of unity pitch ratio. Later experience with the Turbinia proved that at least equal efficiency could be obtained with only one screw on each shaft, and the use of multiple propellers with their undue complication of shaft brackets was subsequently, generally, abandoned.

Although cavitation troubles were rife among the 30-knot destroyers during the 1897–1900 period, their appearance in larger vessels built about that time was rather unexpected, and the trials of the "Good Hope" and "Drake" class in 1901 showed clearly that the low projected area ratios adopted for large vessels about that period were entirely insufficient for the higher powers and speeds then coming into vogue. The same comment might have been made on the propeller proportions of H.M.Ss. Powerful and Terrible, or on those of the "Diadem" and "Argonaut" classes, which immediately preceded the "Drakes," but it must be remembered that at that time it was held that the loss due to an intentional policy of "under-screwing" as regards area for maximum speed might be partially compensated by a gain in efficiency, due to reduced blade friction, at lower speeds. These trials occurred so long ago that reference to them might be redundant were it not for the fact that the data then acquired can be called in evidence to support or rebut the theories of certain causes being contributory to the production of cavitation, but which were only expressed long after the original pressure theory had been formulated. The failure of the "Drake" class to attain a satisfactory speed was immediately followed by a similar *contre-temps* in the case of the earlier vessels of the "County" class, and in both cases the same remedy—a greater projected area on the same diameter—proved equally satisfactory. Table I. gives the leading particulars of the first and final results in the two cases.

Table I.

Vessel.	"Drake" class.		"County" class.	
	Original.	Improved.	Original	Improved.
Date	1901	1902	1902	1903
Length, beam	500 × 71		440 × 69	
Draught	26		24.6	
Displacement	14,150		9,800	
Speed, knots	23.05	24.11	22.79	23.69
Indicated horse-power	30,860	31,450	22,500	22,500
Revolutions	116	122.4	147	140
Diameter	19.2	19.2	16.3	15.9
Pitch	24.6	23.0	20.0	19.6
Pitch ratio	1.279	1.2	1.23	1.238
Expanded area*	76.0	105.0	54.0	80.0
Projected area*	62.0	84.0	44.5	66.5
Projected area ratio	.218	.293	.214	.341
Apparent slip, per cent.	18.0	13.3	21.45	14.35

Remarks.—"Drake" class: Improved, obtained 23.05 with 26,000 indicated horse-power at 116 revolutions = saving of 4860 indicated horse-power; gain at full power, 1.05 knots. "County" class: Original, obtained 20.5 with 16,500 indicated horse-power. Improved, obtained 21.64 with 16,500 indicated horse-power; gain at full power, 0.9 knots.

* On each propeller.

In the case of these vessels two factors intervened, which, quite apart from insufficient blade area, always tend to cause cavitation to occur at an earlier stage than it otherwise would do. These were:—(1) The irregular turning moment of the engines; and (2) the thickness and shape of blade section.

The former was suggested by Mr. Barnaby as a probable factor influencing production of cavitation at an earlier stage than that at which it should otherwise have occurred, but it is very seldom realised

how serious this influence may be. It is particularly important to notice this effect in view of the comparatively irregular turning moments of large marine oil engines.

In the days when these large reciprocating engined cruisers were tried, torsion meters, and especially recording meters, had not been evolved for practical marine use, but subsequent experiments proved conclusively how very variable in extent during one revolution may be the effective torque in the shafting, which is in a state of continual torsional vibration of a very complex character due to the steam pressures and weight of reciprocating parts at one end and to the inevitable fluctuations of propeller resistance at the other. These latter begin to become exaggerated as speeds of rotation and diameters increase. Vibration due to unbalanced forces in marine engines was a serious matter about this period, and the best method of counteracting it was either insufficiently understood or else imperfectly applied. In the "Drake" and "County" classes the Yarrow Schlick and Tweedy system of engine balancing was adopted, but no method of engine balancing can prevent the inevitable fluctuations of propeller resistance* due to variation in head of water over the blades, and to the differences in stream line intensity near the hull of the ship and the surface compared with those lower down and further out. This effect alone is quite sufficient to set up torsional vibrations which will react on any type of installation, and even on geared turbines, if the shaft length is responsive. Cases have arisen even in oil engine work where torsional vibrations have required the substitution of a much greater diameter of shafting. Recording torsion meters† fitted to the shafting of the carefully balanced six-crank engines of the Atlantic liner Kaiser Wilhelm II., showed how very marked this variation of effective torque was even with shafts of 24in. in diameter, and in the case of the German cruiser Hamburg, a twin-screw vessel fitted with three cylinder engines of 10,000 indicated horse-power, and of 23 knots speed, recording meters† proved that at her full speed of 155 revolutions per minute, torsional vibration occurred to such an extent that the effective torque was actually negative at one point of the revolution. This means that at a certain point in each revolution the shaft was actually being twisted momentarily by the propeller in advance of the torque due to the engines. If this momentary displacement of the shaft is carried out, as it must be, to the circumference of the propeller, it follows that there is a sudden increase of slip at this point which must infallibly tend to the earlier production of cavitation. Experiments on the variation in the rate of rotation during a single revolution have even indicated that this influence has been known to be present in the case of direct-connected turbines, but though usually almost negligible in this type, with reciprocating engines it may easily attain as much as a 2 to 3 per cent. variation from the mean rate of revolutions. In the case of the Drake with her first propellers, ship and engine vibration was very marked, and a momentary increase of 3 per cent. above the normal would cause the apparent slip to jump suddenly from 18 to 21 per cent., while the real slip through the wake would rise from about 26.6 to 28.7 per cent.

The importance of this influence on the production of cavitation is best realised by a consideration of the Froude formula for the thrust horse-power delivered by a screw, and which is written :—

$$\text{Thrust horse-power} = B \times \frac{p + 21}{p} \times y \times D^2 \times V_1^3.$$

The method of evolving this formula is very clearly described by Mr. R. E. Froude in his 1908 paper on "Model Screw Experiments" to the Institution of Naval Architects, and, without elaboration, it may be remarked that B represents a power absorption factor based on the area ratio and number and type of blades, p = pitch ratio, D is diameter of propeller in feet, V_1 = speed of screw through the water (*i.e.*, speed of ship − speed of wake) and y is a semi-empirical factor—for which reference must be made to the paper in question—involving also numerical conversion to horse-power, and a correction factor based on model experiments and which is also a function of the real slip. In the case of a seriously irregular torque, such as undoubtedly took place in the Drake's engines, an assumed fluctuation in rate of rotation per revolution of 3 per cent. above the normal would, for the same values of all the other factors in the T.H.P. formula, increase the value of "y" for the above real slips of 26.6 and 28.7 by no less than 14 per cent., while a 2 per cent. variation, giving a real slip of 28 would mean an increase in "y," and hence of T H P, by 9.4 per cent. As $\frac{\text{T H P} \times 326}{V_1}$ = thrust in pounds, we see that, if the real screw delivered the thrust corresponding to its model performance, a momentary increase of thrust pressure per square inch of projected blade area in the region of 10 or 12 per cent. might easily be incurred. As it was, of course, cavitation prevented the realisation of the full amount to be expected from the propeller dimensions and the number of revolutions. Working from the results to be anticipated from the model, the mean pressure per square inch of projected blade area would have run up to 15.15 lb. at the depth at which the tips were working, or, say, 12.75 lb. if corrected to 12in. immersion. This figure was not obtained in full, but it seems clear that the suggested pressure of rather over 11.0 lb. as a result of the Daring's trial was in the neighbourhood of a reliable figure for breakdown pressure for reciprocating engines. In the case of the second set of screws, where cavitation was not apparent, the calculated pressure would appear to have been about 10.4 lb. actual, or, say, 8.0 lb. corrected to 12in. immersion.

That the thickness and shape of blade section also bore no small share in the production of cavitation in this case is less easy to prove definitely. The reason for introducing this point here is that subsequent theories, as we shall show, have laid great emphasis on these being highly important causes. If a blade has a flat face and a parabolic section with mathematically sharp edges, and if the ratio of width of section to thickness at the middle of the blade be, say, 5, 6, 7, 8, 9, 10, &c., then the tangent to the back gives an edge angle of 38.6 deg., 33.7 deg., 29.7 deg., 26.5 deg., 24 deg., and 21.7 deg. respectively. With the heavy blades of relatively low tensile bronze as then employed—*i.e.*, compared with modern strengths—sharp edges were not possible, and the edge angles inevitably exceeded even these figures. At about one-third of the diameter, in the Drake, the width-thickness ratio was less than 6, so that a negative entrance angle at the back of the leading edge of over 8 deg. was incurred in the first set of screws. Negative angles here are very difficult to avoid, and have led later theorists to suggest blade sections in which they are entirely suppressed. None of these later sections, be it said, have shown anything but unsatisfactory results. It cannot, however, be disputed that thick heavy sections, especially if their velocity through the water be high, must involve variations in pressure distribution round the back of a blade, which, compared with thinner sections or with the ideal thin plate so beloved of theorists and so remote from practical fact, are essentially of a very complex nature. Adequate strength and stiffness of blades is essential: very good results have been obtained with comparatively thick sections, and model experiments on blade sections have yielded results which have been absolutely contradicted when tried on a full size scale. In drawing deductions, therefore, regarding the contributory influence of blade section, it behoves one to be very careful. When the area was increased with the same centre line thickness, the angles at the entrance and trailing edges of the blade were materially reduced, and it has been suggested that this modification, quite apart from reduction in mean blade pressure, had a substantial influence in the improvement of the performance. We shall see later why it did not seem to exercise any really important influence, although it cannot be denied that the resistance to rotation offered by a thin blade must obviously be less than that of an unduly thick one. The United States Government experiments on the influence of blade section on actual vessels have been extremely illuminating.

It was during the period covered by the trials of the Drakes, which were fitted incidentally with the most powerful reciprocating engines ever installed in the Royal Navy, that the introduction of the Parsons steam turbine into the mercantile marine was witnessed. This event exercised the most profound influence on screw propeller design. From the time of its first adoption in the Turbinia in 1897, until the advent of gearing in 1909, the history of the development of the marine turbine was one long record of effort to obtain a suitable balance between the weight and efficiency of the turbine on the one hand and the efficiency of the propeller on the other. Prior to the adoption of gearing, the first and most essential step in designing any steam turbine installation was to estimate the highest suitable speed of rotation in order that the turbine might be made as small as possible for any given efficiency. In electrical work the design of generators generally admitted of very convenient speeds, but in marine installations the minimum size of propeller necessary to avoid cavitation—and the attendant inefficiency due to falling off in propulsive effect—imposed a limit by which the dimensions of the turbine were greatly affected. This minimum size required to be calculated at the commencement of any design, as it was almost impossible to assume certain revolutions and subsequently design the most suitable screw. To-day the adoption of gearing admits of wide latitude in the choice of proportions of both turbine and screw, and the principal restriction to the speed at which a turbine can be run, in the case of double gearing, is involved in providing the necessary area through the low-pressure blading without sacrificing efficiency at this point, or, in the case of single gearing, in the restriction imposed by the ratio of reduction.

In the case of vessels propelled by reciprocating engines, it had always been customary to fix the revolutions of the engines to suit requirements as regards cylinder volumes and stroke, and afterwards to design the screw to conform with the revolutions, which were seldom such as to interfere with the adoption of dimensions for good efficiency, except in cases where diameter was limited by draught of water. Propeller design about this time—1897–1903—was very largely a matter of applying empirical formulæ based on the performance of preceding vessels of a similar type. Diameter and area were fixed in this manner, and the pitch was chosen to hold the engines at the desired revolutions at an apparent slip estimated from past practice. The only series of systematic experiments on model propellers of which the results were then available, were those conducted in the Torquay tank about 1884—two years before the Haslar tank was opened—and which were presented in constant form by Mr. S. W. Barnaby to the Institution of Civil Engineers in 1890. These experiments only dealt with variations of pitch ratio as affecting efficiency with blades of constant shape and area, and not in any way with the influence of area or its distribution, and it was not until actual failures to attain the designed speeds occurred, such as in "Daring" or the "Drake" and "Bedford" classes of cruiser, that proper attention was paid to the latter factor, although lack of area, when it occurred, was almost always indicated by the value of the derived coefficients in the empirical formulæ then in use. Experience with large mercantile vessels was usually more satisfactory than with the naval ships of this period. Practice for fast twin-screw vessels showed that the projected surface ratios usually ran from 0.25 to 0.30, with apparent slips of 10 to 14 per cent., whereas the ratio in the cruisers of this period had varied from 0.2 to 0.23 with apparent slips of 17 to 23 per cent. In both large and small naval vessels it was usually in provision of area that errors in design were made; diameter and pitch were often correctly estimated at the start and then altered for subsequent trials, whereas the real fault lay in inadequate surface. The fact is that about the time when the marine turbine was coming into being—1903–1906—propeller design even for reciprocating engined vessels was very far from being a developed science. Dimensions were mainly approximated from previous practice and the only data then available on the methods to be adopted for obviating cavitation were those contained in Mr. Barnaby's well-known book.

Between 1900 and 1912 a very far-reaching change in conditions of ship design took place. This period of development in naval architecture covered the supersession of the reciprocating engine by the turbine in all warships and fast merchant vessels, and the enormous growth in speeds and powers rendered possible by its adoption and by the introduction of oil-firing for boilers; it saw for the first time the use of geared turbines and the adoption of the oil engine in large sea-going ships, and, *far more important still*, witnessed a remarkable advance in the replacement of empirical by scientific methods of design especially as regards experimental tank research work. To mention but three extremely important contributions to our knowledge in this respect during this period, we had, in 1904, Mr. R. E. Froude's paper on "Some Results of Model Experiments"; and in 1908 his paper on "Model Screw Propeller Experiments," both of which were based on data acquired in the Haslar tank. In 1910 Mr. W. J. Luke published the results of experiments on wake and thrust deduction. The exceptional nature of these three papers lies in the fact that the 1904 paper gave the first published series of results of systematic variations of parent forms of hull upon resistance; the 1908 paper gave the first set of model propeller efficiency curves in which the influence of variations of pitch ratio, area ratio, blade shape and number of blades were thoroughly covered; while Mr. Luke's paper embodied the only results of systematic investigations of the influence of propeller position on performance which are available to-day. These three papers have exerted a powerful influence on subsequent design. The former called very serious attention to the influence of even slight modifications of hull form on resistance of the naked hull, the last to the influence of appendages and the vital importance of propeller position. The 1908 paper is probably by far the most important which has yet appeared on the subject of propeller efficiency in open water. Besides these, Mr. D. W. Taylor, between 1904 and 1910, published some extremely useful papers relating to propeller experiments and to hull resistance tests made in the United States Government tank at Washington, and to-day there is little excuse for failure to ascertain either the best form of hull for propulsion within the desired dimensions, the most suitable propeller proportions and the best position in which to place the propeller. It was for this very purpose that Sir Alfred Yarrow founded the Teddington tank.

These advantages, owing to greatly increased facilities for experimental research, might have been thought to have very largely eliminated the risk of trouble due to cavitation, but in point of fact this is by no means the case. The theory of cavitation is still more obscure than it should be, and the phenomenon is to no small extent responsible for some of the difficulty in the way of making analyses of ship trials tally with experimental model results in the anticipated manner. Cavitation troubles on the scale of the Daring or Drake performances are certainly far less frequent to-day than they were twenty years ago; that they still exist to an extent that is appreciably adverse should be patent to all engaged in ship performance analysis.

* See Schlick on "Vibrations of Steamships," T.I.N.A., 1901.
† See Föttinger on "Recording Torsion Meters," Schiffbau Technischen Gesellschaft, 1907.

SOME EXHIBITS AT THE OLYMPIA COMMERCIAL MOTOR SHOW

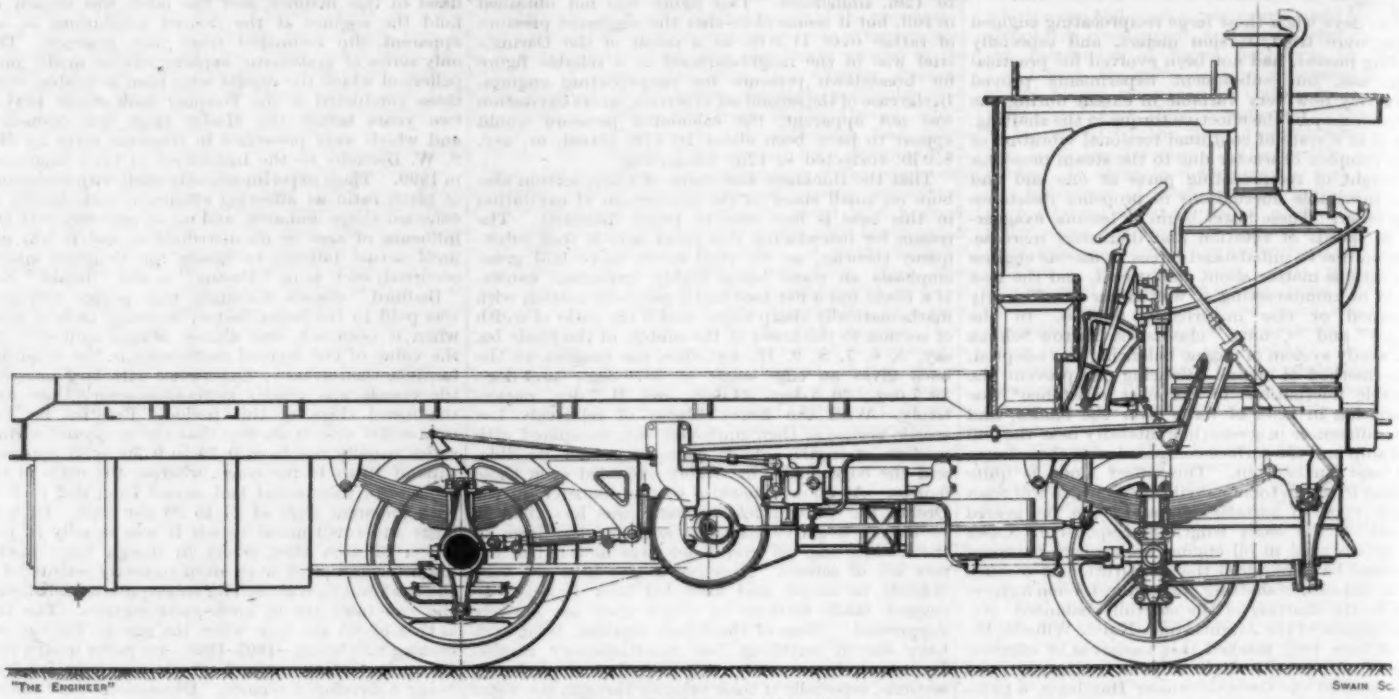


FIG. 10—ATKINSON UNIFLOW STEAM WAGON—*p.* 611/1

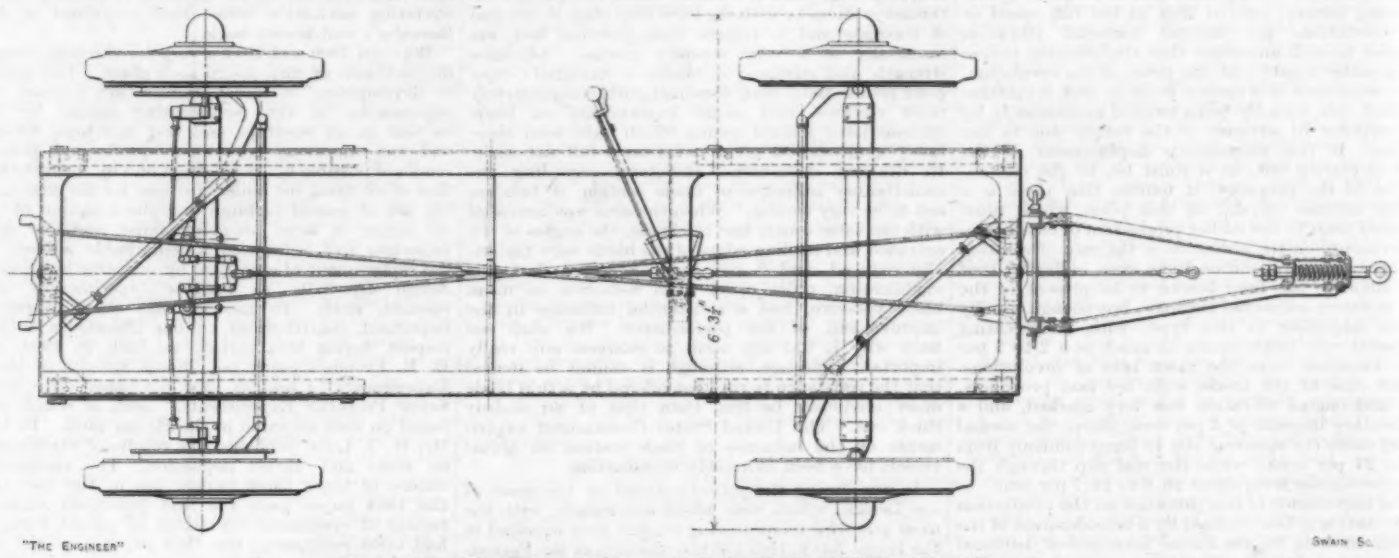


FIG. 11—"ARATO" SELF-TRACKING TRAILER—RICHARD GARRETT AND SONS—*p.* 609/2

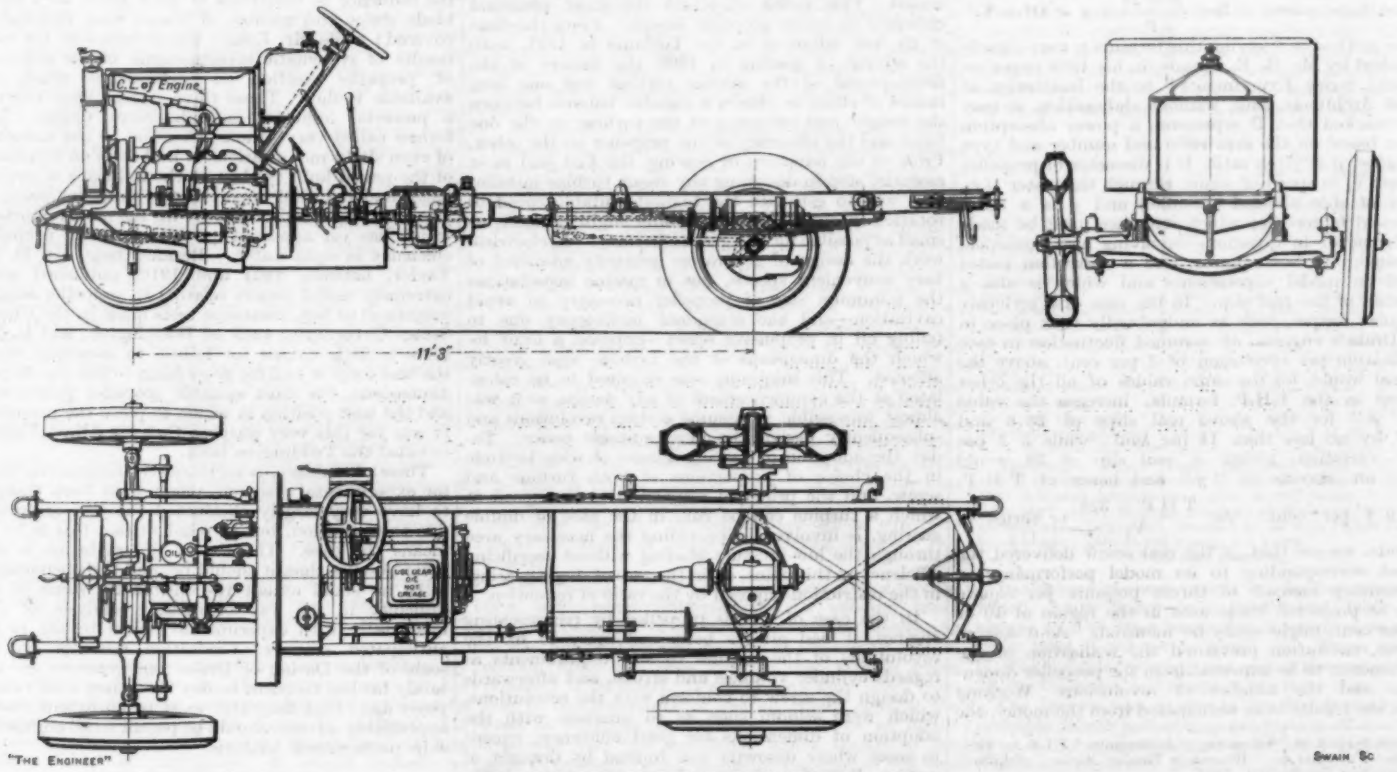
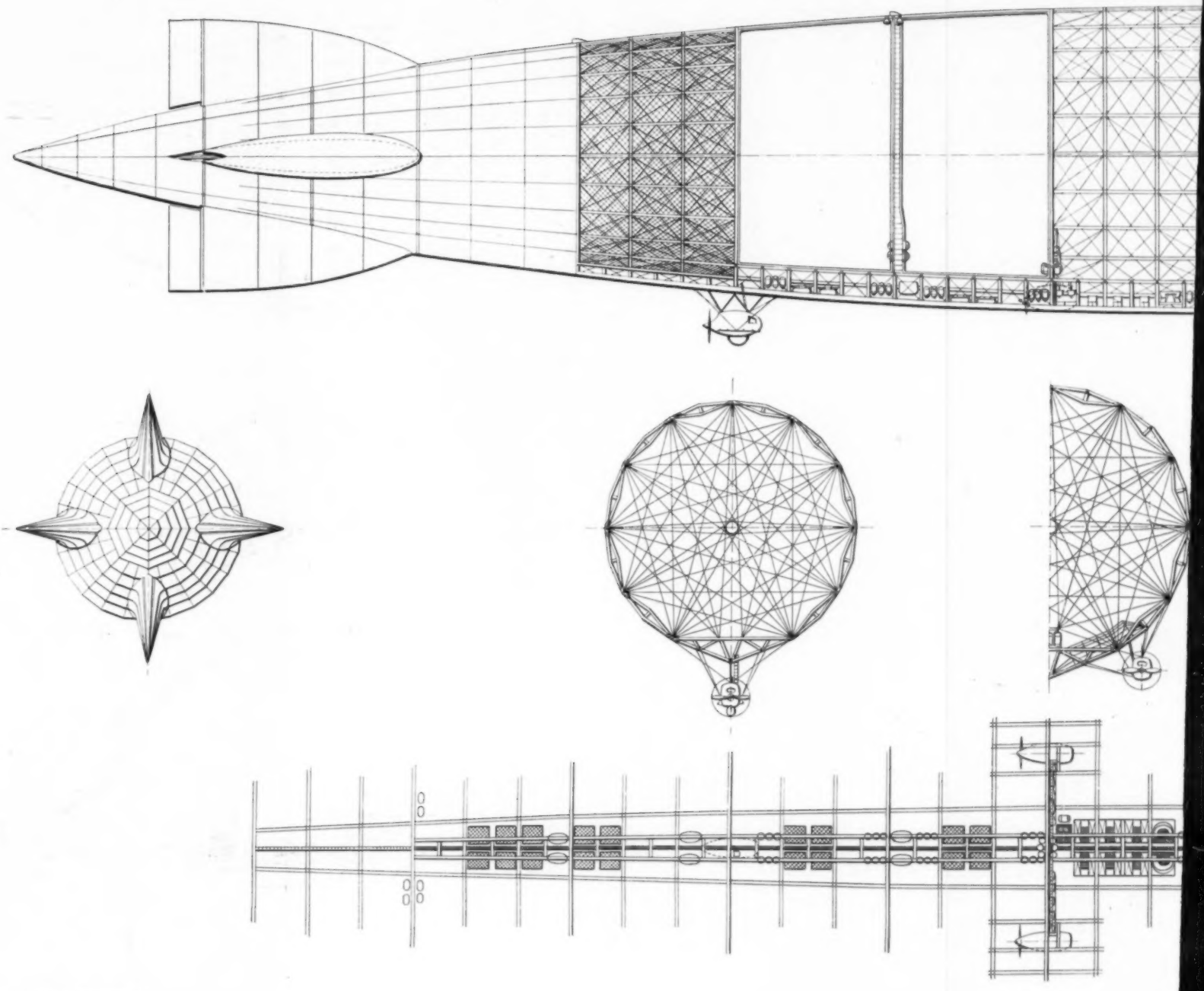


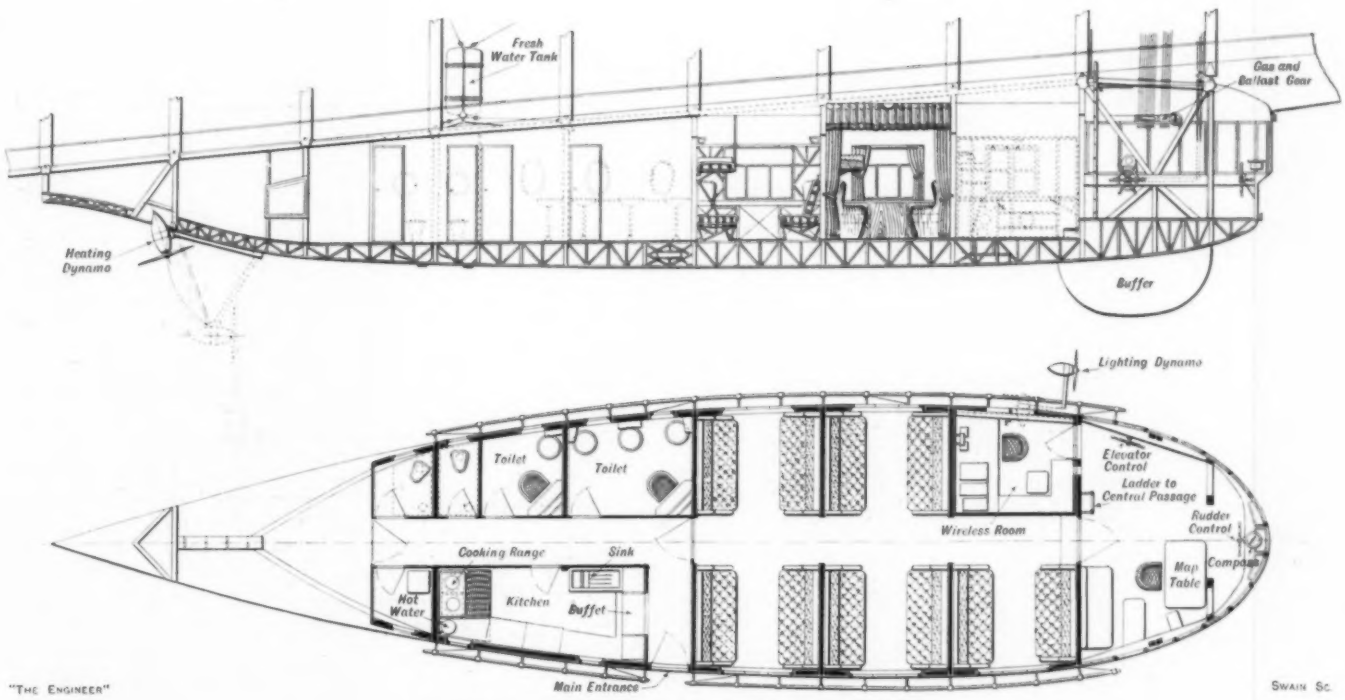
FIG. 12—ALBION 30-CWT. SUBSIDY CHASSIS—*p.* 610/3

THE ZEPPELIN PASSENGER



"THE ENGINEER"

ELEVATION, CROSS SECTIONS AND PART PLAN OF



"THE ENGINEER"

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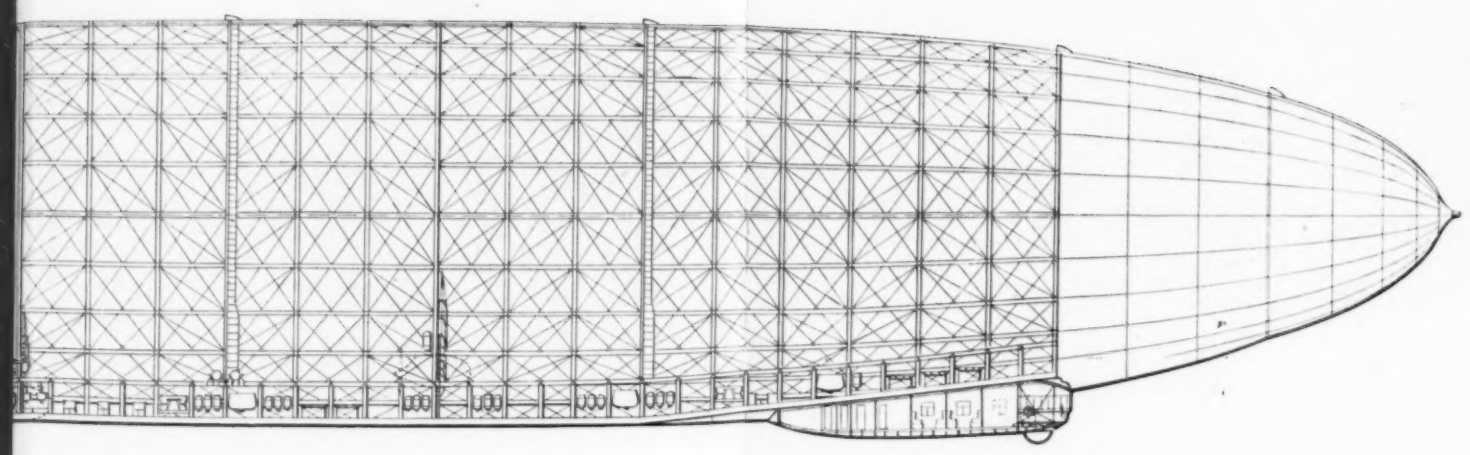
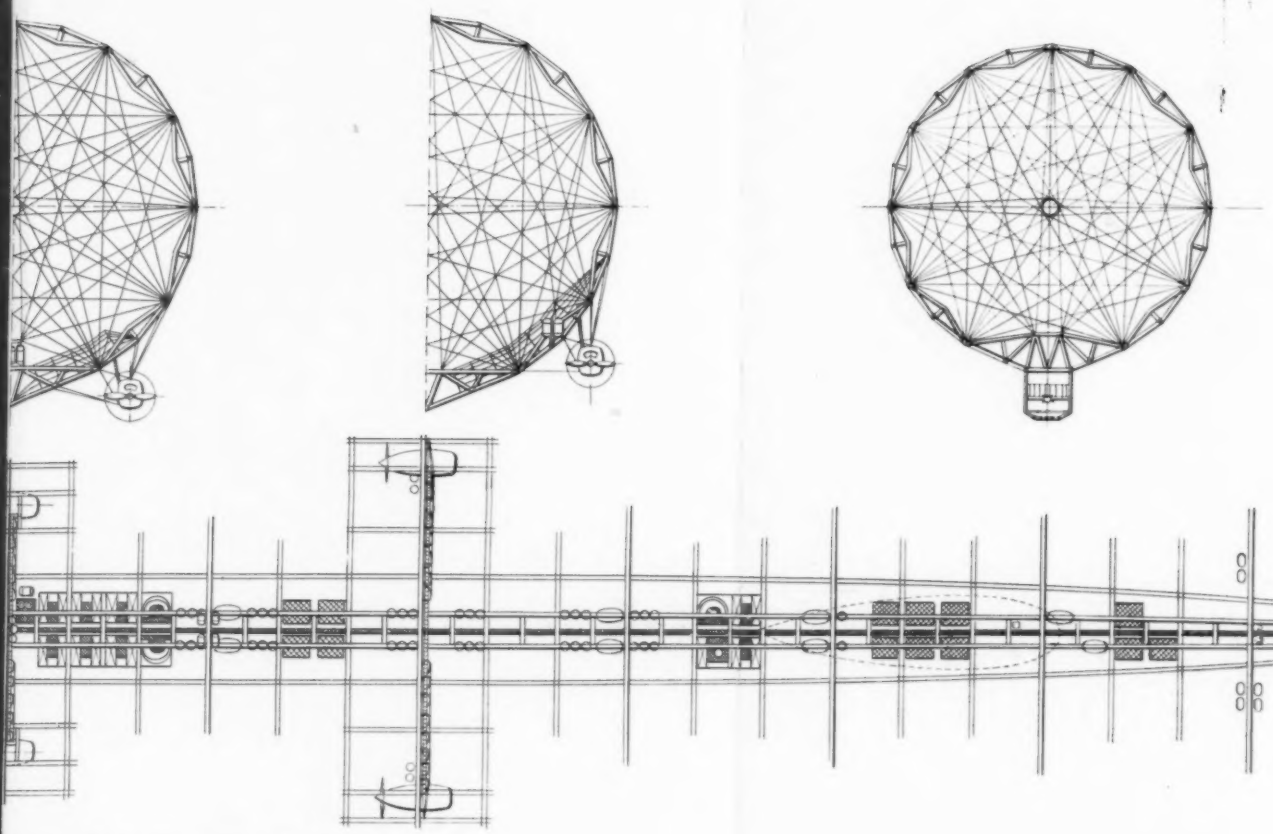
PASSENGER ACCOMMODATION AND COMMANDER'S CABIN

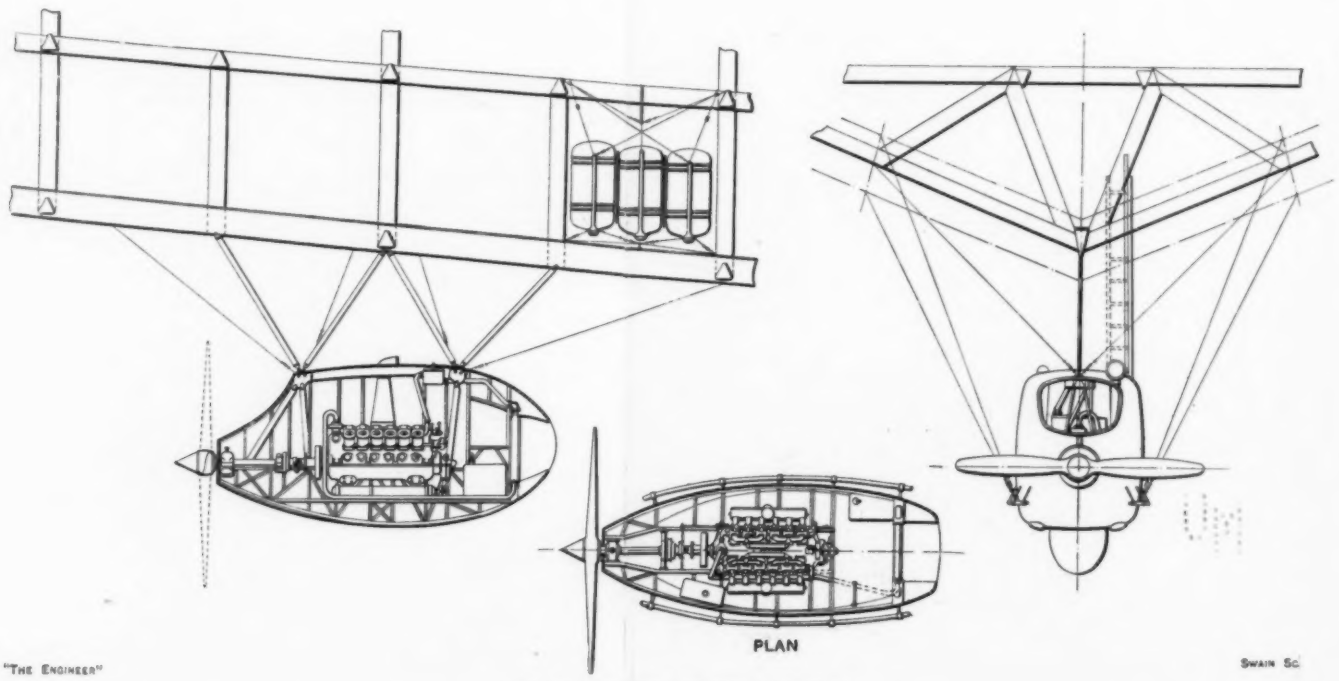
SENGER AIRSHIP LZ 126.





Swain Sc.

D PART PLAN OF FRAME STRUCTURE



"The Engineer"

Swain Sc.

ONE OF THE FIVE ENGINE GONDOLAS

The Commercial Motor Exhibition.

No. II.*

WE have already given brief descriptions of a few of the exhibits at the Commercial Motor Transport and Roads Development Exhibition, which closed at Olympia on December 1st, and the following notes must necessarily be curtailed to the utmost, although there was ample material at the Exhibition to occupy our attention for some time to come. Before going on to our description of the exhibits of a purely mechanical engineering interest, however, we would like to say a few words about the town-planning and road development section of the Exhibition. That part of the show was concentrated in the galleries of the new hall, and although it was quite easily accessible from the ground floor, did not seem to attract the attention which it deserved. Certainly there were no attendants to explain the significance of the exhibits, but most of them, which took the form of maps, either in relief or on the one plane, were self explanatory. They showed incidentally that the civil engineers of the present generation have before them a very difficult problem in adapting to modern requirements the outcome of previous haphazard developments, but there was ample evidence that there are yet engineers with sufficient confidence in their convictions to overcome these difficulties.

The new "Brentford By-pass," of which there was an unusually large-scale model at the Exhibition, is a typical case. It has long been appreciated that Brentford High-street is a serious handicap to all west-bound road traffic, and often enough it has been suggested that the road should be widened, so that the electric trams might continue to provide their service and not interfere with the other road-borne traffic. The expense, however, was decided to be prohibitive, but the new by-pass, which is approaching completion, will not only provide accommodation for the through traffic at a minimum cost, but will also open out for development a considerable district which hitherto has been rather lacking in direct communication with the metropolis.

Apropos of the traffic on the main arterial roads it is noteworthy that there is not yet any decided preference, among haulage contractors, between the merits of six-wheeled vehicles and ordinary lorries with four-wheeled trailers, and there were several exhibits at the show which indicated that manufacturers are endeavouring to improve the simple trailer regardless of the legal handicap under which it is operated as compared with the six-wheeler.

Among the several trailers at the Exhibition there was the "Arato" self-tracking trailer on the stand of Richard Garrett and Sons, of Leiston. As will be seen from the drawing—Fig. 11—there is a crossed linkwork attached to the drawbar of the trailer, which is connected with the wheels in such a way that both pairs of wheels are steered in opposite directions, and there is no tendency for the trailer to "cut the corner fine." The makers, in fact, claim that the vehicle will follow precisely in the track of the engine which draws it. A draw bar and brake connection are provided at each end of the trailer so that it can be hauled in either direction, but the steering system is so effective that the vehicle can be pushed backwards and turned just as readily as it can be manœuvred forward. Another advantage of the system is that as all four wheels are used for steering, each one only needs half the usual lock, with a result that the platform can be arranged considerably lower. These trailers are made in two sizes, for 3 tons or 6 tons, and are fitted with various types of bodies.

On the stand of Baguley, Limited, of Burton-on-Trent, there was the internal combustion loco-

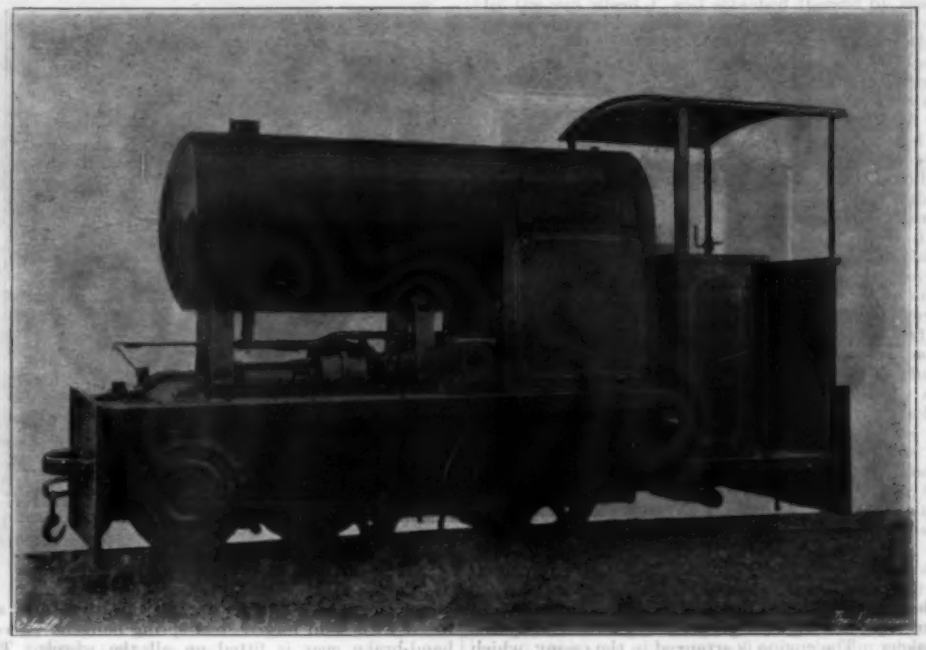


FIG. 14—BAGULEY PETROL LOCOMOTIVE—*p.* 610/1

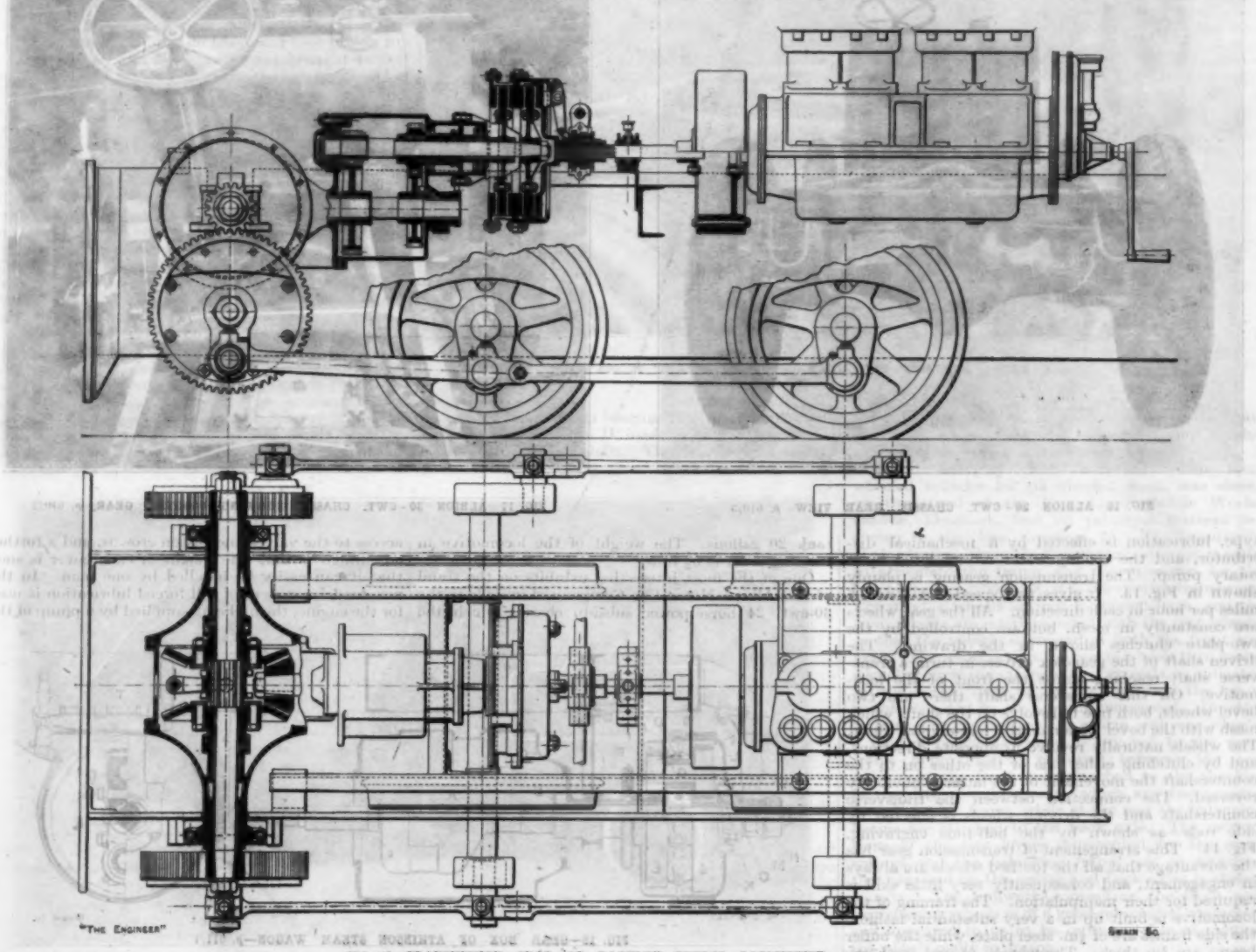


FIG. 13—TRANSMISSION GEAR OF BAGULEY PETROL LOCOMOTIVE—*p.* 610/1

* No. I. appeared November 30th.

motive—illustrated by Figs. 13 and 14. It is intended for heavy commercial haulage work on railways of 60 c.m. gauge, and is equipped with a four-cylinder engine of from 25 to 30 brake horse-power. The cylinders are 4in. in diameter by 5in. stroke, and

FIG. 15—ALBION 30-CWT. SUBSIDY CHASSIS—*p.* 610/2

when using petrol as fuel a consumption of 0.75 pint per brake horse-power per hour is guaranteed by the makers. The engine is arranged in the casing, which somewhat resembles the fire-box of a steam locomotive, but is readily accessible through the side doors. The ignition system is of the high-tension

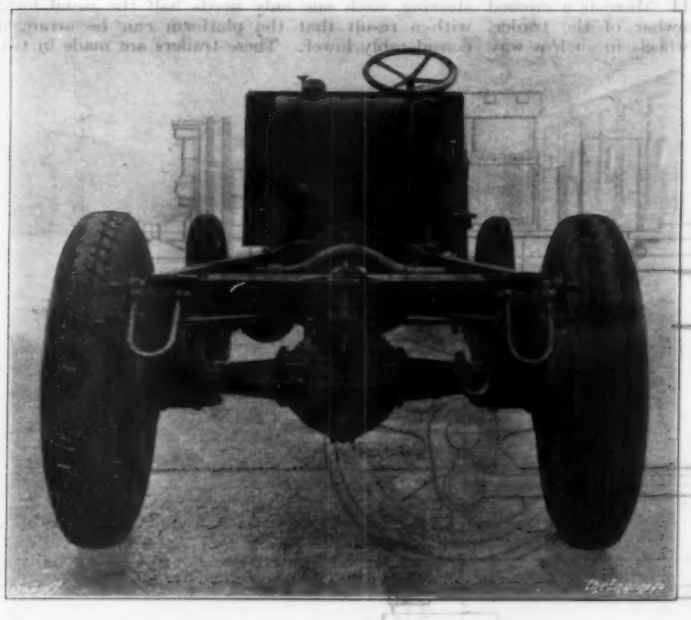


FIG. 16—ALBION 30-CWT. CHASSIS, REAR VIEW—*p.* 610/3

type, lubrication is effected by a mechanical distributor, and the cooling water is circulated by a rotary pump. The transmission gearing is plainly shown in Fig. 13. It gives two speeds, of 3 and 6 miles per hour in each direction. All the gear wheels are constantly in mesh, but are controlled by the two-plate clutches shown in the drawing. The driven shaft of the gear-box drives, in turn, a transverse shaft reaching across the front of the locomotive. On this transverse shaft there are two bevel wheels, both free to revolve on the shaft, which mesh with the bevel pinion on the fore-and-aft shaft. The wheels naturally revolve in opposite directions, and by clutching either one or the other on to the countershaft the movement of the latter is obviously reversed. The connection between the transverse countershaft and the driving wheels is effected by side rods—as shown by the half-tone engraving, Fig. 14. This arrangement of transmission gear has the advantage that all the toothed wheels are always in engagement, and consequently very little skill is required for their manipulation. The framing of the locomotive is built up in a very substantial fashion, the side frames are of ½in. steel plate, while the buffer beams are ¾in thick. The wheels, of cast steel, are 1ft. 8½in. in diameter on the tread, by 2¾in. wide, while the axles, which are made to the British standard main line specification, have journals 3in. in diameter by 5½in. long. The wheels are pressed on to the axles under a pressure of not less than 8 tons per inch diameter of axle. The crank pins, also, are pressed into the place and are riveted over. The axle-boxes and guides are of cast iron, and the boxes are fitted with heavy phosphor bronze bearings, syphon lubricators, and spring pads. The guides are bolted to the frame by turned bolts. The springs are equal to standard main line specification, and are fitted with solid forged steel spring hangers. Screw hand-brake gear is fitted on all the wheels. The blocks are of cast iron, while the hangers and brake gear throughout are of solid forged steel. The water tank has a capacity of 130 gallons, and the petrol tank 20 gallons. The weight of the locomotive in running order is 6½ tons.

One of the most interesting exhibits on the stand of the Albion Motor Car Company, Limited, is the 30-cwt. 24 horse-power subsidy chassis which the company has recently put on the market to conform to the subsidy scheme of the War Office. The lorry—illustrated by Fig. 15—differs from other lorries which have been designed for subsidy use, inasmuch as it is really a standard vehicle with modifications in detail which have been made to bring up the chassis to the subsidy requirements.

Of these the principal are a special ratio of gears, and a rear central spring-controlled towing eye and towing shackles both front and rear. A rear view of the vehicle is reproduced in Fig. M. The chassis is also cross-braced, as shown in the accompanying drawing—Fig. 16—in order to take lateral strains. Another feature is the 15-gallon petrol tank furnished with a reserve compartment enabling 2½ gallons to be used as reserve supply. A two-way cock con rols the two compartments. A small detail of design is the new filling cap fitted to both radiator and petrol tanks, a feature of which is that there are no loose parts on it. The tank and filling cock is illustrated by the view of the control gear given in Fig. 17.

Having briefly enumerated the special points of this chassis, we may refer to the tire equipment. The original scheme provided for giant straight-sided tires—38in. by 7in. on the rear and 36in. by 6in. on the front, and also for the inclusion of a power-driven tire pump. The vehicle can, however, now be offered for the subsidy scheme fitted with 895 mm. by 135 mm. cord-beaded tires carried on steel disc wheels, single tires being fitted at the front and twin tires at the rear. With such tire equipment it is necessary that the hubs be of such a type that they can be fitted with the standard War Department disc wheels which would be required on mobilisation. When the smaller tires are fitted the power-driven tire pump may be omitted provided that provision is made for its addition on mobilisation and that the pump can be fixed in under five hours. The model exhibited at Olympia has the smaller type of tire above referred to.

The plan and elevation drawings reproduced in Fig. 12—show the general arrangement of the chassis. The engine and clutch are generally similar in design to those of Model 20, described in The Engineer of April 27th, 1923, but the following improvements have been made. The cylinder heads are divided, one cover being provided for cylinders 1 and 2 and another for cylinders 3 and 4. This design gives easy

FIG. 17—ALBION 30-CWT. CHASSIS SHOWING CONTROL GEAR—*p.* 610/3

access to the valves and piston crowns, and a further advantage is that the weight of each cover is such that it can easily be handled by one man. In the new model a system of full forced lubrication is used for the engine, the oil being supplied by a pump of the

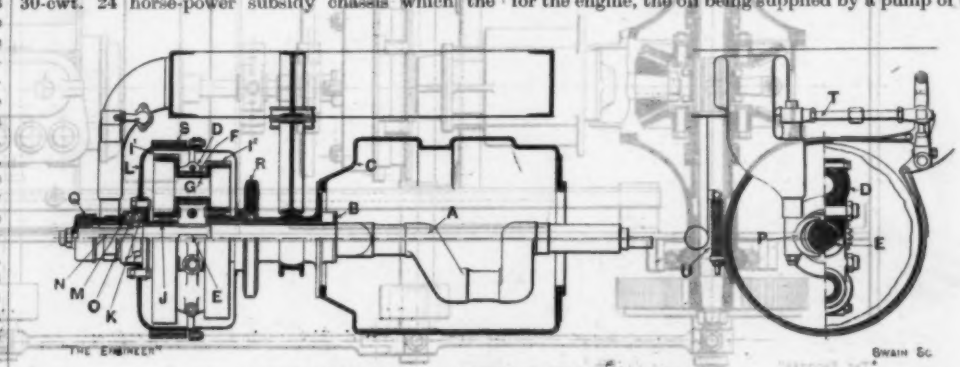


FIG. 18—GEAR BOX OF ATKINSON STEAM WAGON—*p.* 611/1

gear type driven from the cam shaft. In addition to examining the chassis at Olympia, we recently had the pleasure of seeing several of these chassis going through the works at Scotstoun and also making a trial run on one of them. To show the good springing

of the frame an interesting experiment was made. One of the front wheels was jacked up until the other was lifted from the ground with the chassis fully

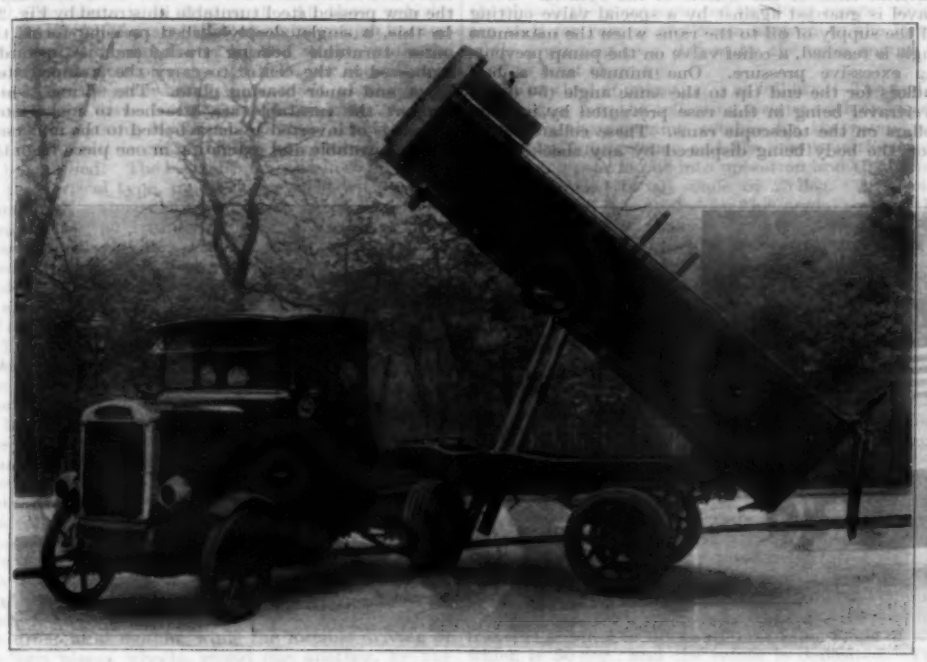


FIG. 19—SCAMMEL SIX-WHEELED TIPPING LORRY—*p.* 612/1

loaded. In this unusual position the engine was kept running and all the controls could be operated, which bore good testimony to the successful means which have been adopted for protecting the control mechanism from the detrimental effects of frame distortion.

In the course of the test run we made we had opportunity to note the good riding and stability of the chassis under extremely unfavourable conditions of road surface. Both the hand and foot brakes are very powerful, and the vehicle was brought to rest on a gradient 1 in 5, by either brake independently of the other. The vehicle is capable of turning in a 45ft. circle, and during the run its cornering was particularly good. Under normal conditions the lorry is governed for a maximum speed of 22 miles per hour, and in accordance with standard Albion practice the governor gear is totally enclosed and so locked that it cannot be tampered with without partially dismantling the engine. The lorry we have described is, without doubt, one of the foremost of the subsidy transport vehicles, and the Albion Motor Car Company, Limited, was, we understand, one of the first firms to put under test a British-built machine, which passed in a satisfactory manner the whole of the test required by the subsidy scheme.

Among the steam-driven vehicles that on the stand of Atkinson and Co., Frenchwood Works, Preston, was interesting, as, although machines by that company have been exhibited for one or two years past, the design is distinctive on account of the adoption of the uniflow type of engine, while several minor improvements have been introduced recently. The general arrangement of the Atkinson 6-ton

FIG. 20—RANSOMES, SIMS AND JEFFERIES SIX-TON STEAM WAGON—*p.* 612/3

steam wagon is given in Fig. 10, while the new epicyclic two-speed gear is illustrated by the drawing Fig. 18. This gear has been introduced on the latest models with the idea of enabling the wagon to maintain the maximum legal speed over easy roads and yet allow it to negotiate hilly country without, in either case, distressing the engine. The gear is of a decidedly robust character, and, as will be seen in the drawing Fig. 18, the crank shaft

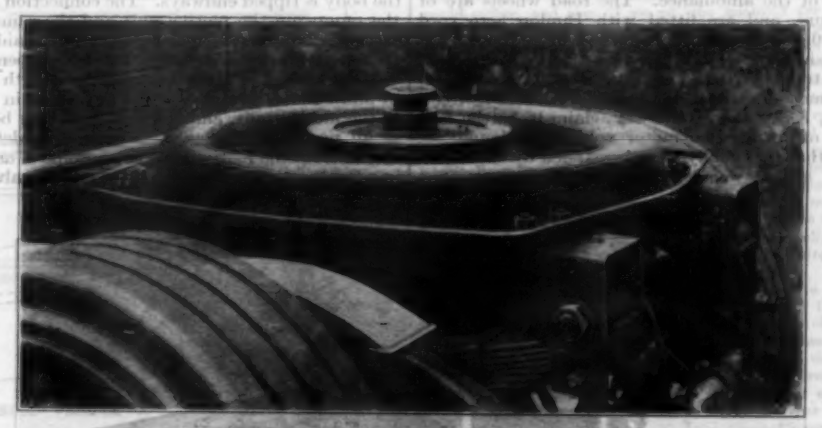


FIG. 21—TURNTABLE OF SCAMMELL SIX-WHEELED LORRY—*p.* 612/3

A, carried in the main bearing B of the engine crank case C, carries an arm D, made in halves, and bolted firmly to the crank shaft. The drive is transmitted by splines E cut from the solid shaft, which engage with corresponding grooves in the arm D. Carried by the arm D, and arranged so as to revolve in gunmetal bushes F, there are two planetary pinions G. These pinions have teeth cut in their rims, as at I^1 and I^2. The teeth I^1 engage with teeth cut in the rim of a sun wheel J, carried by, and concentric with, the crank shaft A. On the face of the sun wheel J dog-teeth are cut, as shown at K. Carried by the sun wheel J, and attached thereto by means of bolts is a brake drum L, to which a dust cover is attached. Excentric with the crank shaft A there is a direct-drive clutch M, which is driven by, and is free to slide upon, splines N cut solid from the crank shaft. On the face of the clutch M are formed dog teeth O, which are so shaped as to engage with the dog teeth K, when the clutch is moved forward by the arm P. A helical steel spring is provided at Q to facilitate the engagement of the teeth K and O. On the crank shaft A, and excentric with it, there is the chain pinion R, which transmits the drive from the engine to the rear axle. Teeth formed on the chain pinion engage with teeth I^3 on the planetary system. A packing gland is provided to prevent the escape of oil. The brake band S, with its operating mechanism T working in conjunction with the brake drum L, is provided. The spring U, attached to the brake band, acts as an anchorage for the band. To bring the top gear into use the direct-drive clutch M is moved forward by the arm P until the dog teeth O and K engage. As the clutch is attached to the crank shaft by means of the splines N, the sun wheel J will be driven at the same speed as the crank shaft A, and, as the chain pinion R is directly coupled through the pinions G, the whole gear will be revolved in its entirety, there being no relative movement between the chain pinion R and the crank shaft A. To bring the low gear into operation, the direct-drive clutch M is disengaged through the arm P, and the brake band S is tightened on to the drum L, thereby holding the sun wheel J stationary. The arm D is now driving, and the pinions G revolve about their own axes and roll upon the sun wheel J, thereby driving the chain pinion R in the same direction as the crank shaft A at a reduced speed. A free engine is provided for by the fact that when the direct-drive clutch M is disengaged, and before the brake band S is tightened upon the drum L, the planetary gears G are free to roll about the chain pinion R, so that the crank shaft A may revolve and the chain pinion R remain stationary.

An interesting system for adapting ordinary four-wheeled vehicles for six-wheeled work, was shown on the stand of the United Automobile Works, Odense, Denmark, and its principal features are shown in the line drawing 25. The peculiarity of this system lies in the fact that no attempt is made to articulate the frame, and the extension for the rear part is firmly riveted on to the existing framework. The driving wheels are not interfered with, and the front wheels are interconnected with the rear wheels, so that the vehicle is steered at both the front and back. The result is that the centre wheels turn round a smaller circle than those at the two ends, as indicated by the dotted lines in the drawing, and the frame is not distorted by the turning movement. In order to share out the load on the centre and rear wheels, a pair of balancing beams is pivoted to the main frame approximately half-way between the two axles. At the front it is attached to the shackles of the driving axle springs, which are disconnected from the main frame, while at the rear the balancing beams are clamped to the back axle. The proportions of the two levers represented by the main springs and the balancing frame are so arranged that the load on the centre and back axles is shared equally. The linkwork connecting the front and rear steering wheels is of a good substantial character, and appeared to us to be quite capable of moving the wheels really in unison.

On the stand of Crossley Motors, Limited, Gorton, Manchester, there was an ambulance body mounted on a 25 to 30 horse-power chassis, similar to those used by the British Flying Forces during the war and since. The engine is of 4in. bore by 5½in. stroke, and has pump water circulation, pump lubrication,

magneto ignition, a Smith five-jet carburetter, and Autovac petrol feed. There are four speeds forward with a spiral bevel final drive and Rudge-Whitworth wire wheels, fitted with 895 by 135 tires. The wheel base is 11ft. 3in. and the track 4ft. 6in. On the same stand there was a 30 cwt. Crossley Government subsidy chassis, which, it is said, was able, during some Government tests, to haul itself through quagmires without assistance, even when down to the depth of the axles. Another important factor is that the chassis is lighter in weight than the average commercial vehicle. Although the speed called for by the War Office is only 25 miles per hour, the chassis under review, when fitted with the ordinary type lorry body, can, we understand, attain a speed of from 40 to 50 miles per hour on good roads. The engine has a bore of $4\frac{5}{16}$in. by $5\frac{1}{4}$in. stroke (Treasury rating, 29.7 horse-power), but is otherwise very similar to that of the ambulance. The road wheels are of aluminium, and are fitted with Dunlop aero cord tires, 920 by D section twin on the rear, and 920 by D section single in front. The wheel base is 11ft. 8in., and the track 4ft. 9in.

Scammell Lorries, Limited, of Fashion-street, London, E. 1, who, by the way, claim to be the first makers of six-wheeled motor vehicles, although we believe that they really were forestalled by one of the earliest steam wagons, were showing some fine examples of six-wheeled tipping wagons, one of which is illustrated in Fig. 19. The machine is built with steel bodies of various sizes to suit the nature of the loads; thus for contractors handling road stone, gravel and sand a body of 9 cubic yards is provided, the capacity of which can be increased by extension sides up to about 12 cubic yards. For materials such as coal, a body 15ft. 6in. long, with a bow front and sides, 4ft. high, gives a capacity of 16 cubic yards, enabling the full 12 tons, which is the normal load of the vehicle, to be taken. A still larger body is made for handling coke, this body, which tips to the end only, having 30 cubic yards capacity. The engine-operated hydraulic rams will elevate the body to a side-tipping angle of 50 deg. in one minute, giving a clear discharge of the load without any shovelling, detachable shelf boards being provided to keep the material clear of the wheels of the vehicle. Overtravel is guarded against by a special valve cutting off the supply of oil to the rams when the maximum angle is reached, a relief valve on the pump preventing excessive pressure. One minute and a half suffices for the end tip to the same angle (50 deg.), overtravel being in this case prevented by internal collars on the telescopic rams. These collars act to stop the body being displaced by any shocks, such as may be caused by letting in the clutch suddenly when the body is at its maximum angle. The ram cylinders are seated on double trunnions, 4in. apart, which gives the effect of a prop with a flat base and eliminates any tendency to lateral instability when the body is tipped endways. The connection between the pumps on the motive unit and the rams on the carrier is provided for by heavily braided and armoured flexible metallic tubing suspended on tension springs. There is sufficient length of pipe to allow the carrier to assume any angle in relation to the motive unit, and the body can thus be tipped in all positions. When it is desired to detach the carrier from the motive unit the oil pipe is uncoupled in a few seconds by a union on the cut-off valve which has a ball valve to prevent loss of oil during the operation. Special screw jacks support the carrier, which can be left at the loading point while the motive unit is taking another carrier to discharge. In this connection it is noteworthy that the coupling and uncoupling of the carrier can be done with the motive unit at any angle, a feature which is a great convenience where space is limited and there is not room for the motive unit to be in a straight line with the carrier.

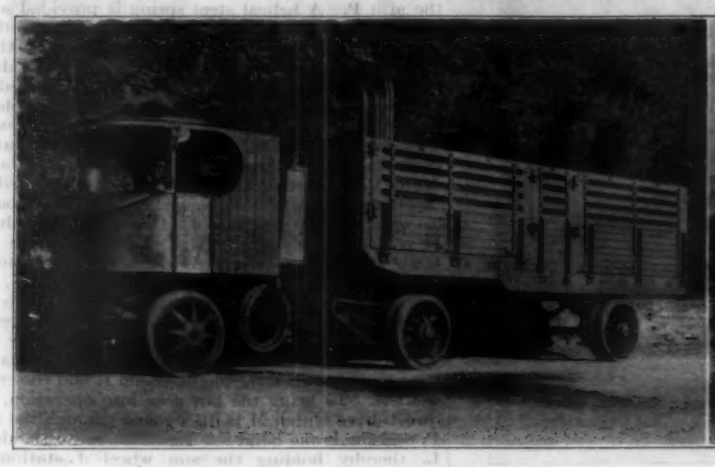


FIG. 22—SUPER-SENTINEL 6-WHEELED LORRY—*p.* 613/1

FIG. 25—SUPER-SENTINEL STEAM WAGON—*p.* 613/1

FIG. 24—SUPER-SENTINEL TRACTOR—*p.* 613/1

The four-cylinder engine has a bore of 5in., a stroke of $5\frac{1}{2}$in., and gives 55 horse-power on the brake. A cone clutch takes the power to a three-speed gear-box. From the gear-box a short universal coupling connects to a separate bevel-driven countershaft, and the final chain drive is by 2in. pitch Coventry chains. A constructional improvement, embodied in the machines shown at the Exhibition, is the new pressed steel turntable illustrated by Fig. 21. In this, a single, deeply dished pressing forms the outer turntable bearing track, and is upwardly embossed in the centre to carry the stamped steel pivot and inner bearing plate. The springs which support the turntable are attached to nickel steel pressings of inverted U shape bolted to the underside of the turntable and extending in one piece from the front to the back, so that the bolts are relieved of practically all stress. Castings have been entirely eliminated in the new design, and the degree of simplification which has been effected can be judged by the fact that there are—counting every nut and split pin as a part—200 fewer pieces in the new type.

The operating mechanism of the carrier brake comprises a bell-crank carried on the underside of the turntable and operated by a hand lever, which actuates a pin sliding vertically through the centre of the turntable pivot. At its upper end the pin bears on one end of a similar bell-crank attached to the frame of the carrier and coupled to the large internal expanding brakes on the carrier rear wheels. The application of the brake is consequently in no way modified by the relative movement of the carrier and motive unit, while the brake mechanism does not interfere with the uncoupling of the carrier, which simply lifts straight up until the underside of its bearing plate clears the top of the brake-operating pin, which is normally flush with the boss of the pivot on the motive unit turntable. The wheel base of the motive unit is 10ft. and of the carrier 9ft. 5in. The driving and carrier wheels are equipped with 12in. single solid tires.

J. and E. Hall, Limited, of 10, St. Swithin's-lane, London, E.C. 4, had, as the principal exhibit a 10-ton six-wheeled petrol wagon, on which one of the most striking features was the system of braking. There is a connection from the cylinder heads of the engine to a strong steel cylinder in which the pressure of the explosions is accumulated under the control of a relief valve. The compressed gases thus stored are used to operate a system of Westinghouse brakes on the back wheels, for which there are separate cylinders. There is, of course, the usual hand lever brake, and it is so connected with the air brakes that the two can be used in conjunction. That is to say, the driver can use the ordinary hand brake in the normal fashion, but if he finds that the vehicle is not pulling up quickly enough, he can, by operating a small lever, accentuate the braking effect by the Westinghouse gear.

Ransomes, Sims and Jefferies, Limited, of Ipswich, had a stand on which there were several electrically-propelled vehicles, already fully described in THE ENGINEER, together with a new steam wagon—shown in Fig. 20—which is chiefly noteworthy on account of the increase in boiler capacity which it represents as compared with its prototypes. It is of 6 tons carrying capacity, and has a special set of gearing so that it can be run, when light, at a speed of from four to five miles per hour above the normal loaded speed of 12 miles per hour. The boiler is worked at a pressure of 225 lb. per square inch and the cylinders of the engine are $4\frac{1}{2}$in. and $7\frac{1}{2}$in. in bore by 8in. stroke. The wheel base is 13ft. $2\frac{1}{2}$in., and the turning radius approximately 26ft. On the same stand there was also a new 3-ton trailer for work in conjunction with the steam wagon just described. It has a main frame and fore-carriage of channel section steel, while the turn plates are of unusually large diameter, so as to give a maximum turning radius on the full lock. The trailer shown at the Exhibition had pressed steel disc wheels, but the makers are ready to fit either cast steel or the artillery type of wheel if either is preferred.

The "Sentinel" Waggon Works of Shrewsbury had a stand on which there were five "Super-Sen-

tinel" steam vehicles—three of which we illustrate in Figs. 22, 23 and 24. They comprised a 6-ton chassis fitted with a miller's tilt van body, a similar chassis without a body, a chassis equipped with a three-way tipping body, the six-wheeler which we illustrate, and the tractor also illustrated. All these vehicles are fitted with the same type of engine, which has two cylinders 6¾in. in diameter by 9in. stroke, while the boiler works at a pressure of 230 lb. per square inch. The boiler is noteworthy on account of the great pains which have been taken to minimise the bad effects of running for lengthy periods with the bad water which it is generally the lot of steam wagons to be supplied. The boiler is orthodox in so far as it is of the vertical type, but it is provided with a large number of water-tubes, and these tubes have been arranged at as steeply inclined a direction as is possible with the idea of accelerating the circulation through them and thus reducing the liability for scale to be deposited on the heating surfaces. There is also an effective system of steam jets for blowing off any soot which may settle on the tubes.

The most striking feature of the engine is the crank shaft, which incidentally performs the functions of the usual differential gear or jack-in-the-box. The crank shaft itself appears, at first sight, to be more or less normal, but, as a matter of fact, it is virtually the framework of a planetary differential gear. The crank pins are bored axially for shafts which carry toothed wheels that mesh together between the crank webs. On the opposite ends of these crank pin shafts there are other gear wheels meshing with wheel or shafts extending through, and beyond, the straight parts of the crank shaft. The sprockets for the main driving chains are mounted on these extended shafts. There is consequently a train of gears from one sprocket to the other, for providing the differential motion, while the forcible driving of the two planet wheels, round one another, by the crank pins, gives the definite movement to the whole train necessary for propulsion. The whole arrangement strikes us as being a most ingenious scheme for minimising the complication represented by the ordinary differential gear, and we understand that it has already survived a test of at least 80,000 miles without showing any appreciable wear. The gear on the wheels is also fitted with a mechanism which prevents the differential system coming into action until one driving wheel tries to absorb from 10 to 15 per cent. more than the other, with the result that skidding is reduced to a minimum, and the vehicle can negotiate most bad tracks without it being necessary deliberately to lock the differential gear.

On the stand of Walker Brothers, of Pagefield Works, Wigan, there was demonstrated a scheme for facilitating the collection of ordinary household refuse by means of horse-drawn containers and petrol wagons. The principle of the employment of these two units—the motor lorry and the horse wagon—is that one motor lorry should work in conjunction with four or five containers. The lorry makes all the long journeys to and from the tip or destructor; the container collects from house to house continuously. The horse-drawn container is approximately 12ft. by 6ft. 4in. and 2ft. 7½in. deep. It is mounted on wheels 21in. diameter, with steel tires. The fixed side of the container is 3ft. 9in. from the ground, and when filled up to this line the capacity of the container is 5 cubic yards. Above the fixed side are folding doors 9in. deep, which give a total capacity of 7 cubic yards and a maximum loading line of 4ft. 6in. The swing doors forming the back of the container allow the refuse a free passage when tipping. The motor vehicle has a standard 4 to 5-ton Pagefield chassis, modified and strengthened to make it suitable for the special nature of the work. The engine is of the four-cylinder type, 120 mm. bore by 140 mm. stroke, and develops 38–40 horse-power at 1000 revolutions. The gear-box gives four speeds forward and reverse. The rear axle is of the double reduction type. The main carrying axle which carries the gearing is formed from a solid forging of high-tensile steel. These three main units of the chassis are generally similar to the units in the "Subsidy" type vehicle by the same makers. On the chassis there are mounted two long ramps, which are used for raising the containers on to the lorry, while a winding gear, driven by the main engine, is used to hoist them up.

The method of operating is as follows:—The motor vehicle goes into the collecting district with an empty container, the retaining catches for the ramps are put out of engagement and the ramps withdrawn; the tipping gear is put into operation and the lifting frame is raised to an angle of 25 deg. A special knock-off stop is provided for this angle, so that the tipping mechanism is thrown out of gear just as the rear ends of the ramps touch the ground. At their rear ends the ramps are provided with special shoes to prevent them doing damage where the road is soft. When the lifting frame is in this position the winch is put into gear for lowering, and the container runs down to the ground on the track formed by the ramps. The horse is detached from the full container by the special quick-detaching means provided, and is attached to the empty container. The motor wagon pulls away from the empty container which it has deposited and backs up to the filled container. The ropes are then attached to this container, the winch control handle put into hoisting position, and the container pulled into position on the lifting frame by the engine. The tipping handle is put into lowering position, the lifting frame returns to the horizontal, the ramps are pushed home into the space provided for them in the lifting frame, and the vehicle is ready for its trip to the tip. To empty, the tipping mechanism is again thrown into gear, the tipping frame is allowed to lift to its maximum angle of tip, which is 50 deg., and the refuse is deposited. The change-over in the collecting district, including the depositing of the empty container and the raising of the full container, from the time the vehicle arrives in the collecting district to the time it is ready for departure, occupies less than five minutes, and when the refuse is being deposited the total time occupied is about one minute.

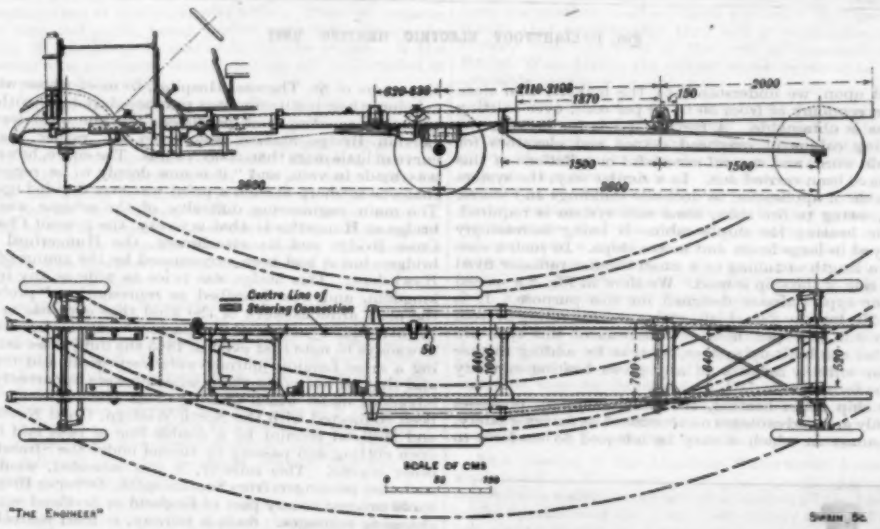


FIG. 25—TRIANGEL LONG-FRAME SIX-WHEELED VEHICLE—p. 611/3

Fodens, Limited, of Sandbach, had a new 6-ton steam wagon fitted with hydraulic three-way tipping gear, a 5-ton with the driving controls so arranged that the driver is better protected from the weather than he was in the original model, and a standard 6-ton machine. Hollings and Guest, Limited, Thimble Mill-lane, Birmingham, had the hydraulic tire presses which we have already described, and a new simple screw press for service where the amount of work does not justify the installation of a large press. The Rover Company, of Coventry, was showing a number of 8 horse-power light vans and commercial travellers' cars, and Dennis Bros., of Guildford, exhibited a new 20–25-cwt. chassis of remarkably low price. There were, of course, many other firms represented at the show, but space does not permit our extending this description any further.

THE Ministry of Transport's railway statistics for August last, just published as a Stationery Office publication, show that when compared with August, 1922, there was an increase of 2.8 per cent. in the freight tonnage conveyed, but as the average length of haul was 51.3 instead of 52.5 miles, the ton-miles rose by only 0.4 per cent. Owing to the reductions in rates made on three occasions during the intervening twelve months, there was a decrease of 10.6 per cent. in the receipts. The average train load fell from 126¾ to 125¼ tons, and the freight train miles rose 3.9 per cent. for an increase of 2.8 per cent. in the tonnage. The rate of movement was also less. The net ton-miles per engine hour were 438¼ as against 456¼ in August, 1922.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

LOCOMOTIVE DRIVING.

SIR,—The leading article in your issue dated the 23rd ult. is an excellent and well-timed refutation of Mr. J. Bromley's statements with regard to locomotive firing. Mr. Bromley ingenuously assumes that only 2 lb. of coal are picked up per shovelful at each firing whilst the engine is hauling a train. Such a quantity is much below the actual figure, this being on the average probably nearer 10 lb. than 2 lb. The rule, of course, is to fire "little and often," but this does not mean that coal must be fed in driblets, irrespective of the weight and speed of the train. The quantity which can be fed per shovelful depends on the length of the shovel and on the fire-door arrangement. For instance, the fire-door on the engines of the Great Northern section of the London and North-Eastern Railway is in reality a double one, and the opening in the running position is restricted by a cross-bar carrying the secondary fire-door on side pivots. The door itself is held at the desired angle—it can be swung inwards—by means of a notched "hook" or sector pivoted in a vertical position in the middle of the upper part of the main fire-door. Thus the space left for firing—unless the main door be opened—lies between the cross-bar and the bottom of the secondary door, and this space will not permit of the passage of a shovel heavily laden with coal. On lines where the full fire-hole opening is used, however, the separate charges of coal would, I think, average about 10 lb. per shovelful. In 1921, Mr. A. J. Hill, the then chief mechanical engineer of the old Great Eastern Railway, issued a circular to the enginemen on that road on the subject of fuel economy. In that interesting little document a shovelful was stated to consist of 14½ lb. of coal, and the usual number of shovelfuls per mile was said to be five. Now, although as much as 14½ lb. could not be got through the secondary fire-door on the Great Northern in a single charge, still it is utterly absurd to say that only 2 lb. are taken up on the shovel at each firing, whatever the number of shovelfuls may be at each operation. Mr. Bromley's figures of 2075 shovelfuls per hour when the speed of the train is 83 miles an hour and 1600 when the speed averages 64, are ridiculous. Many trains do reach 80 miles an hour or more, but they do not maintain that rate for a complete hour. Neither is any train booked at an average of 64 miles an hour in this country at present. On the other hand, most of our more important expresses have to cover fairly considerable distances at a mean rate more or less in excess of the scheduled journey speed. If, therefore, we take the intermediate average speed at 64 and the coal consumption at 50 lb. per mile—Mr. Bromley's own figures—it is obvious that five 10 lb. shovelfuls per mile would suffice, and even if we put the quantity per shovelful at as low as 8 lb., the number of shovelfuls fired per mile is increased by approximately one more only, and in any case would not exceed seven. So that instead of the shovel being wielded 1600 times per hour, as asserted by Mr. Bromley, it would be used from 320 to 400 times, according to whether 10 lb. or 8 lb. represented each distinct charge of coal. This work is well within the capacity of any able-bodied man. As to plying the shovel 2075 times per hour at a running speed of 83, Mr. Bromley ought to have known better than to put forward such a figure. Trains travelling at that speed or at similar rates are usually running on a down gradient, when less rather than more firing would be done. At 8 lb. per shovelful, the number of shovelfuls would be 517; at 10 lb., 415 per hour—a slight difference from 2075. And the train would not be going at over 80 miles an hour for any great distance.

What the railway companies would like to see is a reduction in fuel consumption. Mr. Hill's circular asked for the saving of one shovelful per mile—*i.e.*, firing four instead of five—on the Great Eastern Railway, and if this economy had been effected in 1921, it would have meant a reduction in the coal bill of £312,000 per annum. Similarly on the Great Western Railway, if a single shovelful were saved per trip—not per mile—that company would benefit to the extent of £10,000 per year. In 1921 the coal consumption of all of the Great Eastern engines averaged 74½ lb. per mile, and this high rate connoted a want of understanding on the part of the men as to the great importance of economy in locomotive fuel consumption. Every fireman therefore should endeavour to use as little coal as possible, consistent with the work to be done. At the same time, he would lighten his own task.

In what I have said, I have no wish to underrate the skill and efficiency which our footplate workers in general display. More attention could, however, be given to the coal economy question.

F. W. BREWER.

Stevenage, Herts., December 1st.

THE PIECEWORK SYSTEM.

SIR,—The correspondence in your columns upon the above-named subject has been interesting, but not very informative, since it centred too much upon the vagaries and alleged bad intentions of both masters and men. Of these most engineers have had ample experience, and doubtless human frailty has much to answer for in the difficulties which always attend any system of piecework. To my mind, however, the whole question is, "Does piecework really pay?" I am doubtful if it does.

Successful engineering is, before all other trades, a matter of organisation. Tools and plant of the best, maintained in perfect tune and worked to their full capacity. Materials, the best fitted for the particular job and always ready when required. No wasted time. No unnecessary labour, particularly by skilled men. Wages good, the management efficient and well trained. Under such conditions daywork is cheaper than piecework, and anything short of such conditions cannot be made up by either daywork or piecework. To-day, the guaranteed day rate to pieceworkers is the rule. In addition, the pieceworker demands a price which will enable him to obtain 30 to 40 per cent. over his day rate. Thus the dice are always loaded against the employer. Human beings, like machinery, have an "economical" speed of working; push them beyond that speed and they do not last. Therefore the business of an engineer is to ensure that he obtains full value by recognising and utilising this "economical" rate of working. This can only be done by fair wages, tactful management, avoiding useless friction, the soundest of organisation.

Piecework may for the moment get more out of labour than its "economical" rate of working, but before long the "economical" law will prevail, speed will drop, and ultimately the

piecework shop is paying 30 to 40 per cent. over day rate, just for the sake of a myth. Add to this the additional cost of book-keeping, also the friction, bad work, the delays, all incidental to piecework.

A further disadvantage of piecework is that it directly encourages slack shop supervision, and delays in getting work to the skilled men, who are expected to help themselves, *i.e.*, act as labourers. There is a general tendency on the part of foremen to adopt an attitude, "Well, let him help himself, it is his loss," quite ignoring the fact that it is the firm which ultimately loses through inefficiency.

The most successful, the most celebrated works have been daywork shops. They have been successful by thorough efficiency, both practical and commercial. By doing good work speedily and at a fair price, by avoiding unnecessary overhead charges.

The curse of modern engineering is the domination of the so-called "business man"—otherwise the "share rigger"—who, knowing little or nothing of engineering and caring less, runs up overhead charges and likes to assert that they are a "piecework firm."

WILLIAM B. PINCHING.

London, November 29th.

GOVERNMENT POLICY OF ELECTRICITY SUPPLY

SIR,—Your issue of November 23rd, 1923, contains a letter under the above heading by Mr. H. T. Day, with which I fully agree.

Mr. Day states that the large super power stations will be an excellent key target for our enemies to locate and bomb, and therefore recommends smaller stations containing Diesel engines. As, however, Diesel engines are run on oil which has to be imported, I think it would be an advantage to use engines which would work on fuel obtainable in this country. The supply of fuel oil might be hampered by submarines, and the demand for oil will be excessive for the Navy, &c.; so wherever possible home fuel should be used.

The advantage of internal combustion engines with producer plants is not only economy, but by-products such as sulphate of ammonia, pitch, tar oil, and other tar products can be obtained, and also fuels such as coke, waste wood, &c., can be used with advantage.

It is, however, surprising that the Electricity Commissioners do not seem to realise the advantage of the large amount of waste gases in the form of coke oven gas and blast-furnace gas available in this country. According to the *Manchester Guardian* for January 4th, 1921, it should be possible to obtain from the present wasted or inefficiently utilised blast-furnace gas alone available in this country more power than is generated by all the municipal power stations in the country, and thus save over seven million tons of coal annually. Some objection has been raised against such a scheme, as the gas would not be available at a time of the blast-furnaces being shut down for shortage of orders for iron, but the furnaces could then easily be used as plain producers using coke as fuel, and advantage would be gained in the recovery of the by-products from the coke ovens. A further advantage would be that in the cleaning of the blast-furnace gas a very large portion of the now imported potash would be obtained as a by-product.

With internal combustion engines the water used for cooling the cylinders, &c., can with advantage be kept at such a temperature that it can be used for heating buildings, and by the aid of exhaust boilers a certain amount of steam can be obtained, which can be used for industrial purposes.

I agree that more co-operation is urgently wanted, not only between the various makers of internal combustion engines, but also between the Electricity Commissioners and the public in general, so that the best possible proposals to all interested parties might be adopted, as certainly Mr. Day's criticism on the present grandiose electricity policy is justified.

Ashton-under-Lyne, December 3rd. T. MARR.

RAILWAY ELECTRIFICATION.

SIR,—With reference to your Editorial on the Midi Railway electrification in your issue of November 30th, I notice that you suggest that the split-phase system should be tried in this country, the primary supply being for a three-phase 50-period transmission. Three-phase transmission lines are possible even in Great Britain if the phases are equally loaded—as they are, for instance, when supplying rotary converters or mercury rectifiers—but I venture to say that it would be quite impossible if the phases were used separately for the single-wire distribution to a split-phase locomotive as suggested.

I think you will find that Mr. Bartholomew's remark which you quote related entirely to the trouble due to ripples in rotary converters supplying mostly tramway systems—but also the South-Western Railway—a trouble which is quite easily avoided, leaving direct-current traction in a very much better position as regards inductive trouble than is single-phase traction.

I may add that I have had considerable experience in experimental work on single-phase inductive trouble from the Heysham, Morecambe and Lancaster electrification.

J. SAYERS, Telegraph Assistant.

Derby, December 3rd.

LAGGING WATER MAINS.

SIR,—I should be greatly interested to learn the experiences of any of your readers as to the relative value of covering water mains with earth and lagging them with some such material as slag wool as a protection against frost. Particularly I wish to know what thickness of, say, slag wool would be equivalent to a 7ft. cover of earth.

G. BRIAN HERSEY.

King's Heath, November 27th.

A Tubular Electric Heating System.

THE Lightfoot tubular electric heating system was originally devised for the heating of explosives factories, where a low temperature heat, widely distributed, is required. During the war period it was successfully used for such purposes, and it is now being further developed for industrial, commercial and domestic uses. A typical heating unit is illustrated in Fig. 1, from which it will be seen that it is built in the form of a light brass tube. Inside this tube are placed, back to back, two D-shaped hollow fire-clay tubes, forming two insulated passages with a centre dividing wall of double thickness. The heating coil is made of thin "nichrome" wire, and passes up one side, round the sealed end and down the other side to the terminals of the connecting plug. When raised to its highest temperature, the outside of the tube does not reach more than 160 deg. Fah., which precludes the possibility of any fire risk. Such tubing can be supplied in lengths from 2ft. up to 16ft., and is usually designed for a current consumption of from $^1/_{16}$ to $^1/_8$ unit per hour for each length of 6ft., the rating depending on the duty required from the heater. It is usual to divide any room or space to be heated into different sections, each with its control switch. Full load is first used to warm the room, after which sections may be switched off and the temperature maintained within 1 deg. or 2 deg. of that desired with about half the current, once the room is warm. As will be noted from the illustration already referred to, the tubes may be attached to walls or skirting boards by light brackets, and disposed in the best way, so as to produce the maximum heating effect. Their use for railway coaches, sleeping cars and tramway cars has been experimented upon, we understand, by the makers, who state that an economy of from 50 to 60 per cent. over existing systems is obtainable. A further use is for heating the operating cabins of overhead cranes and elevators for dockside work, and several successful installations of this kind have been carried out. In a similar way, the system is capable of application in dockside buildings and stores, where, owing to fire risks, some safe system is required. Electric heating for ship's cabins is being increasingly employed in large liners and motor ships. In such a case either a length of tubing or a small tubular radiator fixed to the side of the ship is used. We show in Fig. 2 a special four-bar type radiator designed for this purpose. It is about 3ft. long by 28in. high, with a current rating of from 0.2 to 0.3 unit per hour. Radiators of this type are made on the built-up system, so that by adding further two-bar units a radiator of any given heating capacity may be formed.

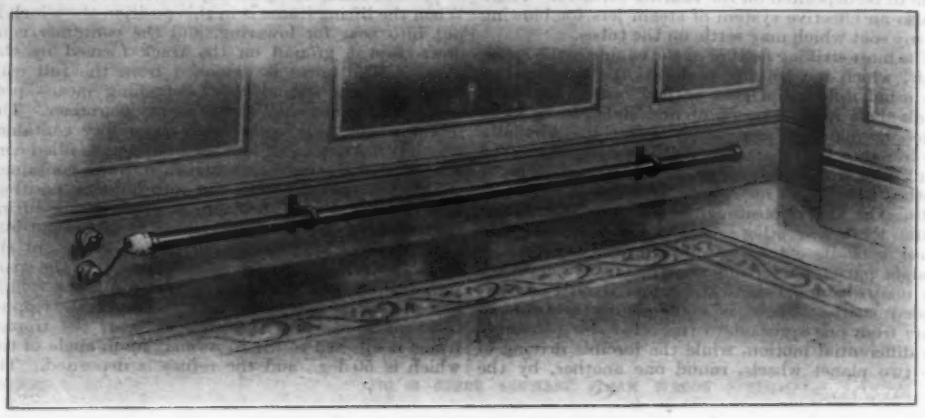


FIG. 1—LIGHTFOOT ELECTRIC HEATING UNIT

For ship cabin heating, the tubular system possesses certainly great advantages on account of its extreme safety, the manner in which it may be adapted to conform to any available space, the wide distribution of heat, and low consumption of current. The heaters described and illustrated are manufactured by Lightfoot Brothers, of 17A, Cooper-street, Manchester, and Mr. Alexander Walker, of 121, Kingsway, W.C. 2, is the sole representative for London and for the marine applications of this system.

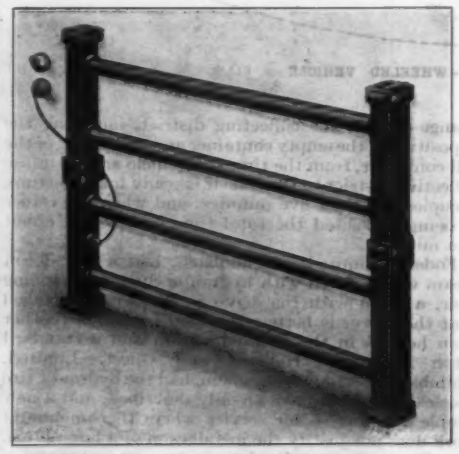


FIG. 2—FOUR-BAR HEATING UNIT

SIXTY YEARS AGO.

IN our issue of December 4th, 1863, we recorded the opening of the Charing Cross Railway, or at least one portion of it, namely, the two miles of railway works connecting Charing Cross Station with the original terminus of the South-Eastern Railway at London Bridge. The line from Charing Cross to Cannon-street, although it was to run over the same viaducts as far as the Borough Market before branching off to re-cross the Thames to Cannon-street Station, then in course of erection, was legally a distinct scheme. It is recorded that the portion of the railway which had just been opened, although it presented no peculiar engineering difficulties, was the most expensive for its length ever built, having cost nearly, if not quite, £1000 per yard. The Governors of St. Thomas' Hospital, it seems, created unexpected opposition to the scheme, which made it necessary for the company to purchase that institution. In addition, "the secret of the intended route of the line was not well kept by those then connected with the management of the South-Eastern Railway, so that property of little value before the railway came was purchased for a mere song and resold to the company at an immense premium." These and other causes led to the final cost of the line being swollen to four times the original estimate. The triangle of ways formed by the lines leaving London Bridge for Charing Cross and Cannon-street stations and the line between these two latter stations is still regarded by some as one of the most dangerous pieces of railway planning in the kingdom. It would seem that in one respect its danger was increased unnecessarily by the opposition of the Governors of St. Thomas' Hospital, to meet whose wishes—before their institution was purchased, indeed, with the object of avoiding such purchase—the line after leaving London Bridge Station was given a "rather sharp" curve of little more than 500ft. radius. The curve, however, was made in vain, and "it is now deeply to be regretted that one so sharp at such a point was ever decided upon." The main engineering difficulty of the scheme was the bridge at Hungerford—that is to say, the present Charing Cross Bridge and its attachment, the Hungerford foot bridge—but it had been surmounted by the genius of Mr. Hawkshaw. This bridge was twice as wide as any in the kingdom, and was described as representing "probably the most arduous work of the kind that ever has or will be attempted across the Thames." It is interesting nowadays to note that even in 1863 the difficulties attending a cross-London journey were very great and trying, and that to overcome them schemes were apparently far advanced under which Charing Cross Station would have been connected with the North-Western, Great Northern, and Midland termini by a double line of rails laid in an open cutting and passing by tunnel under the Strand and other streets. This railway, it was intended, would be such that passengers from Southampton, Dover or Brighton could proceed to any part of England or Scotland without changing carriages. Such a railway, it need scarcely be said, was never made, although to-day the Hampstead and other tubes provide the necessary connections.

LARGE STEAMER FOR THE AMERICAN LAKES.

THE largest passenger steamers for service on the Great Lakes, in the United States, are two paddle steamers recently launched for the run between Buffalo and Detroit, a distance of 265 miles, with shallow waters at both ends of the run. These steamers are 550ft. long, 59ft. beam, 100ft. wide over the guards and paddle boxes, and 23½ft. deep. Each will carry 1300 passengers and 1000 tons of cargo, besides having space for a large number of motor vehicles. A three-cylinder inclined compound engine of 10,000 horse-power, with 9ft. stroke, drives paddle wheels 33ft. in diameter, each wheel having eleven floats 15ft. long and 5ft. wide. Three double-end and six single-end Scotch boilers are arranged in three batteries, the ship having three funnels. The freeboard is high, as rough weather is encountered. Ample reserve power is needed, as the boats make connection with certain trains, many through passengers preferring to make the night run by boat rather than on a sleeping car. Officers and crew number 300. To facilitate handling in narrow channels at the ports, a bow rudder is fitted. The main stern rudder is of the balanced type. There are eleven water-tight compartments and a subdivided double bottom. As the service is specially popular in summer, great care is taken to prevent heat from radiating into the passenger quarters, casings of large design being fitted around the engine and boiler-rooms and uptakes, and beneath the decks. A large proportion of the cabins is equipped with baths, following American hotel practice.

"SHORT HISTORIES OF FAMOUS FIRMS": ERRATUM.—By an oversight the serial number of the article entitled "Short Histories of Famous Firms," which appeared in our issue of November 23rd, was given as XVII. It should have been XVIII. Article No. XVII., which was divided into two parts, appeared in our issues of August 24th and 31st last.

Railway Matters.

IT is announced that the Minister of Transport has appointed Lieut.-Colonel A. H. L. Mount, of the Ministry of Transport, to inquire into the circumstances of the subsidence which occurred on the City and South London Railway on the 27th ult. The inquiry was opened on Tuesday morning last.

IT is now officially announced that the scheme of power signalling at Newport, Mon., which it was said in this column last week was under consideration by the Great Western Railway, is to be the one-lever route system of Messrs. Siemens Brothers and Co. This system is in use at the Great Western station, Winchester, and was described in our issue of February 9th last.

ACCORDING to the *Electrician*, the Halifax Tramways Committee has received sanction to a loan for the reconstruction of the Hebden Bridge tram track. The Ministry of Transport has given consent to the laying of a double line of tramway on the Booth Town section of the tramways between the Punch Bowl Inn and Ploughcroft-lane, and has sanctioned a loan of £2700 for carrying out the work.

AN arrangement for mutual through running of London County Council and Croydon Corporation tramcars between the Victoria Embankment and Purley is suggested by London County Council Highways Committee. Portions of the Croydon tramways track will require reconstruction, a physical junction of the two systems will have to be made at Norbury, and the track under the Norbury railway bridge will require lowering.

A DEPUTATION from Sheffield, which was received last week by the chairman and general manager of the London, Midland and Scottish Railway, was told that substantial orders for railway material had already been placed in that city. The urgency of the unemployment problem in Sheffield and other railway material manufacturing centres was quite appreciated, and tenders for additional material and rolling stock would shortly be asked for.

AN experiment is being made by the Sheffield Corporation Tramways Department with a safety-first device which takes the form of an electric sign fixed to a tram standard stating that the car is going to diverge from the straight course at that particular point. The sign operates both day and night, being worked automatically by the action of the driver in manipulating the points. If the experiment is a success, similar devices will be installed in other parts of the city.

ON British railways—excluding the London tube railways and the Metropolitan District—10.6 per cent. more passenger journeys were made during last August than in the corresponding month of 1922. Including the lines named above, the increase was 7.7 per cent. The increase was wholly in passengers carried at reduced fares; those carried at ordinary fares were fewer in number. Owing to the reduction in fares made as from January 1st last, the receipts were 3.0 per cent. down. The increase in traffic was, however, carried by only 6.6 per cent. more passenger train miles.

IT is proposed to construct a new railway line from Avignon to Nice, which would provide a short cut for through trains from Calais and Paris to the Riviera. At present through trains are obliged to pass through Marseilles, describing a wide loop from Avignon through Arles, and then skirting the Etang de Berre. After leaving Marseilles the line describes a second loop as it follows the coast to Toulon. This would be avoided by the construction of a branch line direct from Avignon. The route to be followed by this proposed branch line has not, however, yet been settled.

NONE of the several obituary notices of Lord Loreburn that we have seen mentioned the fact that he was chairman of the Royal Commission appointed to inquire into the relationship between railways and the State in respect to matters other than safety of working and conditions of employment. The first meeting of that Commission was held on November 14th, 1913, and its work soon developed into what may be called an inquiry as to the relations between railways and the traders. A meeting was held on July 25th, 1914, and then adjourned until October, but, war breaking out, its sittings were never resumed.

A MAN of whom little has been heard, but whose influence was always felt in the administration of the London and North-Western Railway is Mr. H. G. Burgess. He was that company's representative in Ireland for very many years, and its director on the Dublin and South-Eastern Railway. Mr. Burgess filled many offices during the war, among which was that of Director-General of Transport and Coal Controller for Ireland. In the autumn of 1920 it was felt that his long experience and unusual business ability would be of greater service at Euston, and he was appointed principal assistant to the then general manager of the London and North-Western Railway. This office he continued to hold when Mr. Arthur Watson became general manager of that line, and, from the beginning of this year, of the London, Midland and Scottish, and at a meeting of the board of directors on Friday last he was appointed deputy general manager.

DURING the very hot weather of July last an electrical explosion occurred—on the 11th of that month—in one of the motor coaches employed in the South London service of the Brighton section of the Southern Railway. Major Hall inquired into it, and his recently issued report makes it fairly clear that one of the insulators was cracked, owing to the packing between the spindle and the porcelain expanding. The litharge packing contained a 2 to 15 proportion of glycerine, and the hot weather, combined with the moisture included in, or gradually absorbed by, the glycerine, caused this unexpected result. These insulators have a recess of 45 mm., as against only 10 mm. in the Crystal Palace stock, and there was greater likelihood of trouble with the former than with the latter. This fact has been appreciated by the railway company, and all the South London type of insulators are to be replaced by the Crystal Palace type. What happened on the occasion in question was that the discharges arising out of the cracked insulator caused the oil in the high-tension switch to vaporise and eventually to explode.

Notes and Memoranda

THE Saxon textile industry has adopted to a considerable extent the use of special electric motors on spinning machines, and this use is gradually increasing. For connection to three-phase power lines repulsion motors or three-phase commutator motors are used extensively. Both types are especially adapted for use in spinning mills. They are totally enclosed and well protected against dust and damage. The smooth and simple construction of the motors permits easy cleaning and attention. Cooling air is provided through underground ducts, the circulation being produced by fans inside the motor. Where air ducts are not possible water cooling is provided for three-phase commutator motors.

MANY electrical distribution systems have occasional heavy peak loads which result in low voltage on heavily loaded industrial feeders. Under these conditions of low voltage, motors equipped with low-voltage releases are better protected than those equipped with no-voltage releases only. The tendency is for the user of the motors to keep them operating as long as possible, and under low-voltage conditions burn-outs may be frequent unless the low-voltage release is provided. Other advantages accompanying the use of low-voltage protection are that the station is benefited by having the load on the system automatically reduced and, on geared applications, breakages are reduced because sudden jars resulting from voltage fluctuations are elifminated.

THE *Bulletin* of the Imperial Institute contains an article upon the lignite deposits of Nigeria, which are to be found on both banks of the Niger and seem likely to afford a practicable fuel of special value for boats navigating the Niger. The geological relations of the lignite deposits in the Southern Provinces of Nigeria are discussed and the distribution of the beds indicated so far as it is known. Analyses of the chemical composition of samples from various seams are presented and trials reported of the suitability of the lignite for manufacture into briquettes. A large-scale trial of the Nigeria lignite was made by making up a considerable amount of the material into briquettes through the co-operation of a factory in Saxony; these bricks were then used in locomotives on the railways in both the northern and southern provinces of Nigeria with results that suggest that they will provide quite a satisfactory fuel. In view of the cost of imported coal in British West Africa, the subject would seem to be of considerable economic importance.

THE views recently put forward by Mr. L. Murphy before the Institution of Automobile Engineers, which are summarised in the *Electrical Review* of November 16th, are of considerable interest to electrical engineers, in that they indicate that there is a large field for economy in the propulsion of road vehicles by the adoption of the petrol-electric system combined with the battery system. The author states that the ordinary petrol-driven commercial vehicle gives a result of about 40 ton-miles per gallon unladen, rising perhaps to 65 ton-miles per gallon fully laden. A battery-driven vehicle, obtaining its charge from a stationary petrol-driven dynamo, will give 68 ton-miles per gallon, in spite of the low efficiency of this method; but if a generating set and battery are suitably designed and carried on the vehicle, a result of at least 90 ton-miles can be secured under the worst conditions, and this may be increased to 130 ton-miles per gallon under the best conditions. At the same time, advantages are gained by eliminating variable-ratio mechanical gearing and by increasing the mileage per charge.

AT a meeting of the American Waterworks Association Professor Earle Waterman stated that records which should be kept at a waterworks plant should show all facts relating to the operation of the plant—not merely financial items, but also an inventory of plant equipment, a record of the amount of water furnished to the distribution system each day, all changes in the distribution system, installation and removal of meters, meter testing, quantities of chemicals used for treatment, data concerning treatment, and the results of the examination of all samples of water which are analysed to determine the quality. The records should enable the superintendent to operate the waterworks plant in the most efficient manner. If the plant was not operated continuously a study of the operating records should show at what times and for how long a period the plant could be most economically run. Variations in quantity of water available at the source of supply and the variation in ordinary demand, together with the effect of fire demand should be shown, as well as the effect of the seasons both on the quantity and quality of water and on the plant and distribution system. Some old operators, Professor Waterman went on to state, knew these things, but such information could not be as reliable as the written record, and the new man coming on to the job did not inherit his predecessor's memory.

IN the course of a paper on "The Commoner Refractories," read at Birmingham before the University Metallurgical Society recently, the author, Mr. E. E. Moore, dealt at some length with the advantages of the pure silica brick. The silica brick required careful treatment during heating and cooling. It did not deform as a rule until a temperature of 1500 deg. Cent. was reached, but at that point the deformation was apt to be sudden. An increasing quantity of semi-silica bricks was coming into use containing 80 per cent. of silica, which for some purposes were quite suitable, as, for instance, for coke ovens. The essential elements of an efficient refractory were that it would resist slag and compressions at alternations of temperature; also it would stand up well to cutting flames and the impact of gases. The speaker showed by diagrams the superiority of the silica brick to the ordinary fire-clay brick, especially in its resistance to deformation. On the other hand, it was much more susceptible in respect of rapid changes of temperature, and therefore must be heated carefully because of the critical temperature. Silica would melt at 1750 deg. Cent., but under compression the temperature involving failure would probably not exceed 1650 deg. Cent. A point of greatest importance was that in the manufacture of the bricks the highest possible temperature should be employed so as to prevent failure at high temperatures after the brick had come into use.

Miscellanea.

THE Danish Government has decided upon the construction of wireless stations in Greenland. They will be situated at Godhavn, on Disko Island; Godthaab, on the west coast of Greenland; Julianehaab, on the south coast; and the Angmagssauk, on the east coast.

A PAPER on "The Lesser-known Electrical Utilities" was read by Mr. James Orr at a recent meeting of the Paisley Association of Electrical Engineers. The author dealt with a variety of matters, ranging from ship steering to pyrometry, and touched upon "daylight" illumination, mercury arc rectifiers, &c.

AS an instance of the growth of the low-powered marine oil engine, it may be mentioned, states the *Motor Ship*, that the first Atlas-Imperial engine was put into service in 1916. It was of 250 horse-power. During the next year the builders delivered 1295 horse-power, and 1400 horse-power in 1918. Orders on hand at the present time bring the total Diesel output of the Atlas-Imperial Company up to 25,000 horse-power in engines up to 400 horse-power.

THE First Experimental Report to the Atmospheric Corrosion Committee of the British Non-Ferrous Metals Research Association will be presented and discussed at a meeting of the Faraday Society, to be held on December 17th, at 8 p.m., in the rooms of the Chemical Society, Burlington House, W. 1. The very comprehensive series of field tests and laboratory experiments described in the report were carried out by Mr. W. H. J. Vernon on behalf of the Committee.

INSTRUCTIONS have been issued to the head masters of Worcestershire elementary schools to remove existing radio apparatus on their school premises. This step has been taken, it is stated, in consequence of damage done to property and danger arising to school children through climbing on roofs of schools to inspect aerials. We think, states the *Wireless World and Radio Review*, it would have sufficed in the circumstances if schoolmasters exerted their authority to keep their pupils out of danger. The new measure appears rather drastic and will deprive scholars of a form of practical study which could only be to their advantage.

THE winter meeting of the Institution of Water Engineers will take place at the Geological Society, Burlington House, W., on Tuesday, the 11th inst., at 2.30 p.m., and on Wednesday, the 12th inst., at 10.30 a.m. The chair will be taken by Mr. H. C. Head, M. Inst. C.E., M.I. Mech. E., and the following papers will be read and discussed:—"The Somerford Pumping Station, South Staffs. Waterworks Company," by Mr. Frederic J. Dixon, F.R.S., M. Inst. C.E.; "Waterworks Supply Legislation," by Mr. Percy Griffith, M. Inst. C.E.; "A Comparison between British and American Waterworks Practice," by Mr. G. Mitchell, M. Inst. C.E.; and a lecture by Mr. H. J. F. Gourley, M. Inst. C.E., on "The Geology of the Catskill Scheme, New York."

IT is estimated at the present time that 40 per cent. of the motor cars in use in Ontario are closed models, which are rapidly gaining in popularity. In some instances dealers report that 70 per cent. of their orders during the past year were for closed models, and all believe that the principal market in the future will be for this type of vehicle. Practically no European cars are sold. As in the other provinces of Canada, price, service facilities, and petrol consumption are determining factors in motor car sales. The nationality does not influence prospective purchasers. About 75 per cent. of the trucks in use are light trucks up to and including 1 ton. Another 15 per cent. are delivery wagons and the balance are heavier trucks of various types.

AT the first meeting of the Informal Section of the Institution of Electrical Engineers, the president, Dr. A. Russell, opened a discussion on "Engineering Training." He said it was agreed that a student's training should be practical and theoretical, but the difficulty was to determine how long each should last. It was very important in the national interest that some of the best boys should be attracted into engineering. The public schools aimed generally at scholarship and letters because successes there reflected glory on the school. Engineering success should be equally glorious. The idea of raising the status of the profession by stiffening the examinations was wrong. Clever boys were often eccentric and unable to pass examinations creditably.

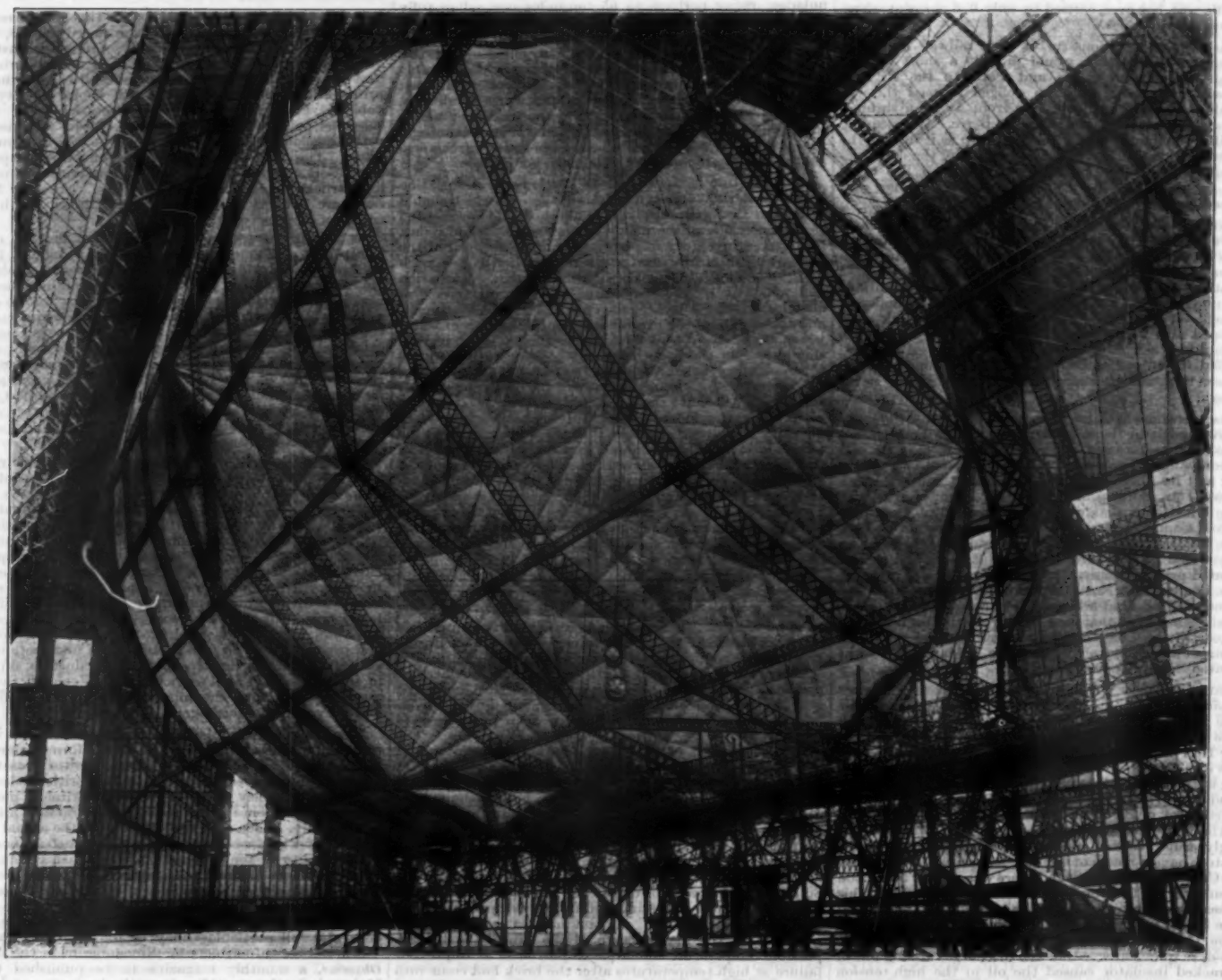
THE Electricity Commissioners have issued new regulations for the use of overhead lines. These regulations make considerable alterations in those now in force. The revised code now put forward has been adopted after consultation with various sections of the industry through the medium of a special committee of the Institution of Electrical Engineers. It is not to have retrospective effect, but will apply to all future overhead lines erected by authorised undertakers in Great Britain. The regulations are divided into two parts: general and specific, the latter being subdivided to cover pressures not exceeding 650 volts direct-current and 325 volts alternating-current and pressures above those values. The first section deals with the material strength and size of conductors, supports, factors of safety and service lines. Each of the sub-sections deals with the minimum height of conductors and provision to guard against danger.

THE British Meteorological Office announces an important step towards supplying ships with information regarding the existing weather around the British coasts and forecasts for the seas adjacent to the British Isles. On January 1st a new series of broadcast wireless messages will be issued from the Air Ministry Station at 9 a.m. and 8 p.m. daily. Each message will contain the actual observations of wind, weather, pressure, barometric tendency, and visibility at ten stations on the British coasts taken only two hours before the broadcast issue. The messages will also give a general inference of weather conditions and forecasts for twelve hours for eleven sea districts; at the end a further outlook will be given when possible. The code and full particulars may be found in the Board of Trade notices to mariners for November or in the *Marine Observer*, a monthly magazine to be published by his Majesty's Stationery Office from the beginning of 1924.

THE ZEPPELIN PASSENGER AIRSHIP LZ126

(For description see page 604)

INTERNAL VIEW LOOKING ALONG KEEL



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TWO-PAGE SUPPLEMENT—THE ZEPPELIN PASSENGER AIRSHIP LZ 126.

THE ENGINEER.

DECEMBER 7, 1923.

Waste Heat Recovery on Ships.

THE paper presented before the Institution of Mechanical Engineers on Friday evening last by Dr. Mellanby was devoted to a review of the marine Diesel engine practice of the Clydeside engineering and shipbuilding firms. On the preceding night the same paper was discussed in Manchester, and as our report shows, the discussion there, as might have been expected, centred around the broad features and the details of design of the various engines described and illustrated in the paper. Interest was also shown in the curve given by Dr. Mellanby representing the relationship of the mean indicated pressure to the amount of oxygen present in the exhaust gases. In London, however, although reference was made to the last named point, it was a very noticeable fact that practically all the speakers dealt with one particular aspect of the subject, namely, the available or possible means of recovering some of the heat lost in the cylinder jackets and the exhaust gases of heavy oil engines. It would perhaps be an exaggeration to say that the discussion was confined to the Still engine, but it is not wholly beyond the truth that it was all but confined to that interesting form of prime mover, and to other means of utilising the waste heat for the purpose of the generation of steam or of hot water. That such should be the case suggests very strongly that renewed and keen interest is now being taken in this aspect of internal combustion engine design, and that many engineers are seeking to improve, not alone the efficiency of the cycle on which the engine works, but to increase the proportion of the maximum efficiency actually realised with a given cycle of operations.

One of the most important ways of increasing the mechanical and thermal efficiency of a prime mover is to turn to use some of the heat which is usually allowed to go to waste in the exhaust gases and the cooling water. As usually practised, waste heat recovery takes little account of the latter source of heat, because, as a rule, the temperature at which the water leaves the jackets is too low for useful service, although the amount of heat available is large. If we take a typical heat balance for the average Diesel engine, about 42 per cent. of the heat in the oil fuel supplied appears as indicated horse-power, of which some 11 per cent. is lost in negative work, leaving about 31 per cent. available at the shaft as brake horse-power. Of the 58 per cent. of the heat in the oil fuel which is discharged 20 per cent. goes to the jacket water and 38 per cent. is carried away in the exhaust gases. The amount of it which can be recovered from the exhaust depends on the initial temperature of the gases when entering the exhaust boiler. The best conditions are realised, of course, when the engine is running at full load. Under these conditions a temperature of 800 deg. Fah. at the boiler may be taken as representative of four-stroke cycle Diesel practice, but with two-cycle engines, owing to the large amount of scavenging air, this temperature seldom exceeds 550 deg. to 600 deg. Fah. With gas engines much higher temperatures are reached, between about 900 deg. to 1000 deg. Fah. It may be well to point out that thermometers and thermo-couples placed in the exhaust ports of Diesel engines only give a qualitative and not a quantitative record of the heat present in the gases. It is not an overstatement to say that the readings recorded are often from 200 deg. to 300 deg. Fah. too low on account of the rapidly varying gas conditions in port areas. With exhaust gases at the initial temperatures we have mentioned, the amount of steam which it is possible to raise from feed water, say, at 60 deg. Fah. to steam at 140 lb. per square inch pressure, taking normal fuel consumptions and not neglecting boiler radiation, may be estimated at about 0.5 lb. per brake horse-power hour for two-cycle engines, 0.8 lb. for four-cycle engines, and 2.0 lb. for gas engines. These figures vary widely, of course, with the conditions under which the engines are running and the fuels they are using. If hot water only is required large quantities can be readily provided, but at temperatures below boiling point trouble is likely to be experienced with tar and oil deposits on the heating surfaces when the engines are working on low or variable loads. Furthermore, where fuels having a high sulphur content are used, the condensation of products of combustion in the boiler may lead to serious corrosion taking place. In the Still system very special means are adopted for recovering not only the heat in the exhaust gases, but also the cylinder jacket heat and that from the piston. The important point is that the temperature of the cylinder jacket water is increased to the evaporation temperature of the steam used in the cylinders, so that steam is formed both in the exhaust generators attached directly to the exhaust port belts and also in the jacket spaces, while further heat is abstracted from the exhaust gases as they pass through the boiler tubes and the feed-water heater. It must not be forgotten also that considerable heat is given up to the steam as it passes over the crowns of the piston and cools them. In all stages of expansion in the engine the steam is kept dry and it reaches the turbine with a slight degree of superheat. The high temperature of the cylinder jackets has an important influence on the character of the exhaust gases. When examining the tubes of one of the Scott-Still exhaust generators, we failed to find any evidence of oil or tar deposit. We are informed, however, that after very long runs a light coating of reddish ash, which is slightly greasy in character and may be wiped off with the finger, is found in the generator and boiler spaces. No doubt the cleanness of the exhaust is in part due to the high temperature combustion conditions within the Still cylinder, and by the fact that a certain and not inconsiderable amount of lubricating oil is carried over by the steam, and hence does not appear in the exhaust. It is subsequently recovered in the exhaust oil separator and the feed filters. In the summary of trial results of the Scott-Still engines of the Dolius given in our issue of November 23rd, figures are given which show the amount of steam evaporated to be slightly under 2 lb. per brake horse-power hour—a result approximating to the best gas engine exhaust heat recovery practice. We do not think, however, that Mr. Still would seek to claim the improved efficiency as the sole advantage of his system. He lays stress, and rightly we think, on the increased reliability of the engine and the flexibility at starting and under manœuvring conditions. These are important factors in any marine installation, and may in the long run prove of more consequence than saving 9 or 10 per cent. of the fuel. It must be remembered that fuel economy is always badly watered down by the general economy of a plant. Thus, for example, in a case dealt with on another page—of a waste heat boiler equipment in a gas engine power station a net economy of 16 per cent. in gas consumption was whittled down to no more than 3½ per cent. for the whole station.

Up to the present waste heat recovery, both on land and in marine oil engine practice, has been retarded from the lack of a small light and efficient boiler, which might be placed directly in front of the exhaust ports of the engine cylinders. Mr.

Clarkson's boiler represents an interesting experiment in this direction, and the exhaust pipe waste heat boiler referred to by Dr. Mellanby would seem to indicate lines on which considerable advancement might be made. We have, of course, marine engineers who give it as their opinion that no steam is required when at sea. It is notable, however, that most motor ships are furnished with an auxiliary steam boiler large enough in almost all cases to do more than meet Mr. Still's requirements. There are certainly many purposes for which steam generated by the main engines might be usefully employed to reduce the complexity and cost and increase the reliability of the auxiliary machinery. We cannot share Mr. Clarkson's opinion that one of the engines of a large quadruple-screw liner might be replaced by a steam turbine driven from the exhaust steam generated by the remaining three engines—at least with our present knowledge and practice of exhaust heat recovery. It does seem, however, that steam so raised might, as in the case of the Still equipment, be used to drive steam turbo blowers to furnish the necessary scavenging air, and a further use for steam would be, if the German experiments referred to in the discussion are successful, to pre-heat the scavenging air and thereby reduce the size and output of the blower plant. Sufficient has been said to indicate the wide field for research and experiment which the subject of waste heat recovery at sea opens up. It is not too much to expect that still further advances will be made which will further enhance the efficiency and reliability of the heavy marine oil engine.

Extended Piston Rods.

THERE are, in locomotive practice, a good many details concerning which a considerable divergence of opinion can be found; one of them is the use, or otherwise, of piston tail rods. The object of the extended rod is, of course, to delay the wearing of the cylinder barrel and piston, and thus to increase the mileage obtainable between the boring out of cylinders and the renewing of piston heads. At first sight it would seem that so simple an adjunct as a tail rod would hardly form a subject for discussion, and it is only by considering the matter in connection with others related to it that its importance can be appreciated. In these circumstances, our surprise that the matter should have been found worthy of discussion at the annual meeting of the Mechanical Division of the American Railway Association, held in June last, is diminished.

This discussion revealed the fact that piston size is, in America, the leading factor in determining the use, or non-use, of tail rods, and in cases where a definite opinion was expressed as to the advisability of using extended rods the minimum piston diameters were given. The effect of the materials used either for the piston or the cylinders seems to have hardly been mentioned. It was apparently just touched upon in the report which formed the basis of the discussion and no more. Looking at the question from the point of view of cylinder dimensions, there is little doubt that increasing sizes first directed attention to the use of a tail rod, but in British practice size does not seem to be the governing factor. Here we have not occasion to use—nor, indeed, could we use—cylinders of the diameters to be found in the United States. The largest ever used on British locomotives were the 30in. low-pressure cylinders employed by Webb in his larger three-cylinder compounds, and of these engines only those of the "Teutonic" class were, we believe, fitted with tail rods; and, if our memory serves us, those rods were done away with before these particular engines were finally withdrawn from service. While it is perfectly true that extended rods have been used by different railways at different periods, their use in this country on anything like an extensive scale only took place with the general introduction of superheated steam, and in the earlier days of superheating many, possibly most, engines employed them. Broadly speaking, it would seem that where railways had been in the habit of fitting tail rods before the use of superheaters, they have continued their use since, and where tail rods had not been used with saturated steam they were introduced with superheated steam. Indeed, it was laid down as a definite condition that "neither the cylinder barrel nor the stuffing-boxes must at any time carry any part of the weight of the piston" (Garbe). In more recent years there has been a good deal of departure from that practice, and it is quite common to find superheater engines without tail rods. During recent years the use of either forged or cast steel pistons for the purpose of lightening the reciprocating parts has increased. When these materials are employed it is, of course, necessary to increase the clearance between the piston and cylinder, and the additional support afforded the piston by an extended rod may be regarded as desirable. Yet there are instances of steel pistons with the same clearance and having an equal number of rings, both fitted and not fitted with tail rods. Taking what we may call the general view of the subject, it appears that size, so far as practice here is concerned, has little bearing on the question. If, for any reason, a steel piston is preferred, then prudence would seem to dictate the use of a tail rod. If, on the other hand, a cast iron piston is considered sufficient, then it may be made a closer fit in the cylinder, and an extended piston rod is not required, or, at any rate, does not appear necessary. But whilst cylinder wear, of course, depends, in some measure, upon the weight of the piston, there are other factors affecting it, and an important one referred to in the American report is the quality of feed water. On this subject it is stated that the character of boiler water has a direct bearing on lubrication, and is of more importance in saturated than in superheated locomotives, as the carrying over of water and solids into the cylinders—which is more likely to occur on saturated engines—has an important effect on wear. Another matter mentioned is that some railways operate superheated locomotives either with drifting valves or require engine-men to run with the throttle just open when drifting. This practice, it is stated, has an important bearing on wear and again reflects on the question of the use of tail rods.

Both the report and the subsequent discussion developed the fact that there is a considerable diversity of opinion as to the value of tail rods, and we may say at once that the same conditions appear to hold in this country. Speaking in the discussion on the report of the A.R.A. Committee, Mr. Kiesel, of the Pennsylvania system, said that the Pennsylvania had a great many extended rods, but he did not know whether they ought to be kept or not, and he added that he doubted if maintenance was good enough to make extended rods really effective. Of course, the form of tail rod, with its attendant slide and other details, used in American practice, is a much more complicated arrangement than the comparatively simple sleeve and sheath type employed in Bristol practice. On the question of counterbalancing, Mr. Kiesel remarked that by eliminating cast iron rims from steel pistons and making a solid steel facing, the weight extended piston-rod was about equal saved by taking off the cast iron rim, to that so that the extended rod made little or no difference to the reciprocating weights.

Public Works & Transport Congress.

No. III.*

WE conclude, in what follows, our abstracts of the papers which were brought before the Public Works, Roads and Transport Congress, which was held at the Agricultural Hall, Islington, from November 22nd to 29th last.

In our last issue, the last papers dealt with were those which were considered at the afternoon conference on Tuesday, November 27th. On the Wednesday morning three papers were presented. The first, which was read at a conference arranged by the Institute of Public Administration, was by Mr. A. T. V. Robinson, Controller of Cost Accounts at the War Office, and was entitled "The Organisation and Equipment of an Accounting Department." As it deals with matters of general rather than of particularly engineering interest, we do not propose to give an abstract of it.

The Quality and Composition of Town's Gas.

The other two papers, which were both considered at a conference convened by the Institution of Gas Engineers, were "The Quality and Composition of Town's Gas," by Mr. H. E. Bloor, Engineer, Secretary and Manager to the York Gas Company, and "The Position of Mains in Highways," by Mr. Stephen Lacey, Assoc. M. Inst. C.E., Distributing Engineer to the Gas Light and Coke Company. Mr. Bloor commenced by remarking that, as employed by the Gas Engineer, the word "quality" applied to gas, connoted something which could be expressed in two distinct ways. A gas had a "quality" of X candle-power, or Y B.Th.U. per cubic foot. A gas engineer, on being informed of the quality of the gas supplied in any district, knew that, if expressed in terms of candle-power, the quality was imposed by Statute, and must be maintained until power to vary was obtained by legal process. If, on the other hand, it were expressed in B.Th.Us., he knew that the quality had been freely chosen by the gas undertakers, and might be changed at will, subject to certain conditions. The transition from an illuminating power basis, rigidly fixed for each undertaking and only able to be altered by Special Act, to a highly flexible calorific value system, such as we now had, was the result of a long process of evolution enormously accelerated in the later stages by the war and the immediately post-war period. The author then pointed out that a right understanding of the issues involved in a discussion of the quality and composition of gas demanded, therefore, some acquaintance with the history and statutory control of the industry, and his paper, in consequence, had, he said, assumed the form of an historical survey, leading up to the passing of the Gas Regulation Act of 1920.

The history given is most interesting. It traces the progress of gas supply from the first time it was used publicly—namely, when Winsor lighted the Lyceum Theatre in 1803—right down to the present day, detailing, amongst other matters, the methods of making charges, &c. It is, however, already in an exceedingly compressed form, and does not lend itself to abstraction or summary. Mr. Bloor then discussed at length the Gas Regulation Act of 1920, which he described as the gas industry's New Charter. The scope and working of the Act was reviewed, and the paper concluded with a discussion of the composition of town's gas, the various constituents being reviewed.

The Position of Mains in Highways.

Mr. Lacey, in his paper, brought out one point which is not always taken into account when the question of street congestion is being considered. It was that the weight of gas distributed by the three Metropolitan gas companies, through their underground mains, is about a million tons per annum. By far the greater part of that quantity of gas was, he stated, used for heating and cooking, and was consumed in appliances which had displaced others using raw coal. If it were possible to revert to the use of coal for those purposes, at least 4 million tons per annum would be required, and the whole of that weight, together with the ashes arising from it, would have to be carried by road.

In determining what position mains should occupy in public highways, the author said that there were two chief points of view to be considered: (*a*) They should be laid in positions which would necessitate the least possible disturbance of the road either when originally laid or subsequently, and (*b*) attention must be paid by the undertaking owning the mains to the relative costs incurred by the adoption of alternative positions. He thought that it would generally be found that these two contrasted points of view led to conclusions which were not in conflict with one another. Mains were of two kinds—trunk, or feeder mains, and service mains. It was generally agreed that service mains should be laid under the footways on either side of the road. In thoroughfares with wide footpaths, it might be practicable to lay trunk mains as well as the smaller mains under the footways, but usually the latter were not wide enough to do more than accommodate all the service mains and cables. There was, however, less objection to laying trunk mains than service under carriageways, for the reason that as no service pipes were connected to them they were not often opened up after having once been laid.

The construction of subways had often been advocated as a remedy for the opening up of roads for alterations and additions to mains; but subways could only be economically built under special conditions. An examination of existing subways in London showed that they had practically all been built in new roads. To build subways in existing roads, already congested with mains, would involve not only the cost of building the subway, but the cost of diverting the existing mains, and the outlay would prove to be prohibitive. In considering the question it must always be remembered that the distribution systems of the gas supplies had, in the very large majority of cases, been laid for a number of years.

As regarded the great schemes of reconstruction and widening of main roads which were now being carried out all over the country, the owners of mains were, Mr. Lacey remarked, often faced with an unprecedented and serious situation. It might be, for example, that a main properly laid in the original road at a uniform depth would, if unaltered, be found to be wandering from side to side across the new road, and at greatly varying depths where the construction involved alterations in levels. It was obvious that if mains were to be left in such positions under new roads, the surface would be liable to be continually broken up by openings on the main for alteration and repair. It would, therefore, appear that those road authorities took the long-sighted, as well as the equitable, view, which looked upon the cost of diverting such mains as an integral part of the cost of construction.

Stray Electric Currents.

Only one paper was taken on the Wednesday afternoon. It was presented to a Conference arranged

* No. II. appeared November 30th.

by the Incorporated Municipal Electrical Association, by Mr. F. Charles Raphael, M.I.E.E., and was entitled "Electric Strays." Omitting leakage currents from telegraph and telephone circuits, which could cause no damage to pipes or buildings, electric strays, the author said, might be divided into three categories:—(*a*) Leakage of return current from the rails of tramways and railways; (*b*) leakages from, and faults on, electric light and power mains; and (*c*) leakages from electric light and power installations in buildings. It was the leakages coming under the first heading—those from tramways and railways—which had hitherto forced themselves most on the attention of engineers connected with other services. In the United States of America and also in Germany it was found that, within a few years of the introduction of electric tramways, gas and water mains suffered considerable damage owing to electrolytic action. It had originally been anticipated that the whole of the current after it had passed through the tramway motors, would return to the power-house by the rails, since they afforded the path of least electrical resistance. The possibility that some of this return current might leak from the un-insulated rails and find its way back through the earth, and any metal pipes buried near the tramway route did not, at first, give the electrical engineer any serious concern, as such leakages would not in any way diminish the power supplied to the motors of the tramways nor affect the efficiency of working. In some American cities, however, the electrolytic action of the stray currents was sufficiently great to cause serious destruction of gas and water pipes within a comparatively short time. In this country the development of electric tramways had been retarded by Parliamentary restrictions, and, when the time came for the construction of lines on a large scale, information was already available as to this electrolytic action, and the Board of Trade imposed regulations to limit the permissible pressure drop on the rails and the potential difference between rails and neighbouring pipes which prevented a repetition of the experiences of America and Germany. On the whole, said Mr. Raphael, although a number of well-established instances had occurred, we in this country had been wonderfully free from trouble for this source, but it would be fatal to relax the existing precautions on that account.

The means taken to minimise "strays" were reviewed, and the paper concluded with a note on the effect of electrolytic action on reinforced concrete.

Changes in Road Construction and Maintenance.

All the Conferences held on Thursday, November 29th, had been arranged by the Institution of Municipal and County Engineers. Four papers in all were considered. The first, which was by Mr. H. Collins, Assoc. M. Inst. C.E., Borough Engineer and Surveyor, Colchester, was entitled "Changes in Road Construction and Maintenance." The author explained that power-drawn scarifiers were not introduced until about the year 1893. Up till that time the preparation of old road surfaces for recoating was carried out by manual labour. The process was expensive, as well as being arm-destroying, and was rarely efficiently done. Hence, new coatings were put on old carriageways, which eventually got so high, relatively to the channels, that dangerous conditions arose.

In many towns, after the introduction of the scarifier, it was found possible to maintain the roads for considerable periods with the scarified materials. In the author's own borough, following on the outbreak of the war, by taking advantage of the high crowned roads, and scarifying deeply, it was found possible satisfactorily to maintain the five most important main roads during the years 1914–1915 and 1915–1916 with one-tenth of the usual quantity of new stone per annum as compared with the average of the eight preceding years.

Mr. Collins then went on to discuss the various attributes, of water-bound surfaces, surface tarring, tar-macadam, grouted roads, bituminous macadam, stone-paved streets and wood paving, and declared that the last mentioned remained probably the best surface for heavily-trafficked town streets. Of all the wood paving of which he had had experience—and that experience covered oak, jarrah, karri, creosoted and uncreosoted pine, pine treated with other preservatives, sectional blocks, &c.—he was most distinctly of opinion that creosoted pine blocks were the best.

As concerned foundations, the author remarked that with respect to reinforcement in road concrete work, it depended on the subsoil whether the cost was commensurate with the advantage. If a road had to be constructed over an unstable marsh, reinforcement was essential, and, to be effectual in economical work, the slab should be reinforced near both its bottom and top surfaces. He thought that, with good concrete, shear reinforcement was not essential as, with a slab, the areas in shear were relatively large. With a thoroughly hard bottom Mr. Collins' experience is that even concrete, and, therefore, much less so reinforcement, is not necessary.

Road Foundations and Carpeting.

The second paper was entitled "Road Foundations and Carpeting—a Review," and was by Mr. Ernest Worrall, M. Inst. C.E., who said that if all earth formations had the plane and congruity of, say, alluvial deposit, the known conditions would permit of the design of foundations on an ordered and systematic plan. As they were, in fact, of multifarious composition, deposition and plane, any attempt to dogmatise in methods of covering them for road foundations would be presumptuous. Sundry data had, however, been collated by the common process of trial and error, and they had necessarily to be accepted, subject to due care in their application to particular cases, as groundwork in determining the type and quality of foundations.

Given favourable attendant conditions, the coarse gravels made as good an underbed for pavement foundations as any natural formation could do. The finer gravels and dry sand might be placed next in order of merit, provided that the latter was precluded from lateral spread. Rock was seldom found with its laminæ in the required contour or plane of the road section, and hence the unequal filling involved on some, caused variable settling or yield in the covering material. Loam, clay and peat, in the order given, came last in fitness as underbeds in foundations. Where they were encountered and could not be avoided, ample drainage was essential, and the capacity, spacing and frequency of the drainage ducts could only be determined in each particular case as the conditions of each might require.

Among the first road makers to recognise the importance of foundation work was Telford, and his method of pitching over the underbed with hand-placed rubble was at once the provision of drainage and the distribution of traffic weights and shocks over as large an area as possible. The method had served its purpose for nineteenth-century traffic and would still be serviceable off the main arteries; but the cumulative effect of increasing weight and speed of main road traffic was fast overtaking the adequacy of such a type of foundation. With what, then, should we replace existing foundations? Unquestionably, in the author's opinion, cement concrete was the material that would best answer current and prospective requirements, and must, sooner or later, be adopted for the purpose. An important feature of cement concrete for road foundations was that there was no internal movement and, consequently, no interstitial wear. *Per contra*, it had been calculated that in a ballast and macadam road, the internal grind and wear amounted, in a time proportionate to the place and weight borne, to as much as 30 per cent. of the whole.

After reviewing the composition and the best method of making concrete, the author touched, in turn, upon reinforcement and carpeting, and macadam, tar-macadam, asphalt mixtures, setts, wood blocks, all-concrete and rubber for surfacing purposes.

The Evolution of the Road and Transport Thereon.

The third paper, by Mr. F. Marsden, City Engineer and Surveyor of Bradford, was entitled "The Evolution of the Road and Transport Thereon." Its author commenced by saying that through the missionary work of the late Road Board and the present Ministry of Transport, and various institutions, it had now become a fact acknowledged by the general public that good roads formed one of the best assets which a nation could possess, so far as material possessions were concerned.

Mr. Marsden then lightly touched on the history of the formation of roads. In the days of the first tracks, he said, man was simply an agriculturalist, cultivating the soil for his own immediate use. At that time the lines of the paths were very largely supplied by the instinct of the cattle, especially sheep, forming their own tracks from the hills into the valleys for the purposes of watering and shelter. The next development was the mule, or horse track, followed, in the sixteenth century,* by tracks for wheeled vehicles, although, for a considerable period, town to town and village to village traffic was maintained by the packhorse. The institution of turnpikes, and their abolition by the Local Government Act of 1888, were then noted, and, said the author, from the passing of that Act, the development of the roads had been practically continuous up to the present day. The increase in motor traffic on the existing highways had brought about a problem in road construction which, in the national interests of safety, economy and revival of trade, would permit of no unnecessary delay.

The problem was to find a road which was suitable for all the needs and classes of traffic passing over it. The variations in weight, character and speed, made it, under present conditions, nearly impossible to fulfil all the requirements without reconstructing and adopting new lay-outs and cross sections. Various devices, such as six-wheeled vehicles and trolleys, had been brought out to prevent unnecessary damage to the surface of the road, and with those improvements, coupled with improved road surfaces, the damage by so-called "extraordinary traffic" had gradually diminished in quantity. The chief thing now was to devise means whereby traffic could be classified according to its speed, so as to produce the greatest margin of safety to other users of the road. The author reproduced diagrams showing his proposals for ascertaining the correct cross section in three main roads, each with a total width of 100ft., which he is at present constructing. The first showed the cross section of a road, making provision for an independent tramway track on each side of a central roadway, 40ft. wide, the 100ft. being made up by two footways, each 15ft. wide, and two tramway sections, each also 15ft. wide. Another diagram showed the tramways running down the centre of the road, with two 27ft. roadways on each side, while in the third both lines of tramways ran down one side of the road, which was 40ft. wide. It was hoped, he added, by these experiments, to arrive at some definite decision as to the best allocation of road surface. Unfortunately, though, such roads could not be instituted in built-up areas, but sufficient experience had now been gained to show clearly that the wider road was more economical than the narrower road, was much safer, and tended to promote the health and benefit of the general public in a much larger degree than did the narrower road.

* Mr. Marsden has apparently overlooked the Roman roads.

The Road Beautiful.

The fourth paper, and the last, brought before the Congress was entitled "The Road Beautiful," and was by Mr. J. L. Redfern, who, in addition to being Borough Engineer and Surveyor of Gillingham, is also an A.R.I.B.A. As may be imagined from the title of his paper, the author pleaded for a little more attention being paid to the making of roads less unsightly than they sometimes are. Proper regard for proportion, a careful selection of materials, and attention to detail, would produce a result which would merit the appreciation of those who had to use the roads, and redound to the credit of the designer. We should, he urged, keep at the backs of our minds the idea of making our roads beautiful. In time, the habit would be created, and the result would be all to the good. Among the many suggestions made for carrying his plea into effect, was that telegraph and telephone wires should be relegated to underground conduits, and thus banished from highways, while "a good tree should be planted to mark the spot where once a pole stood."

Literature.

SHORT NOTICES.

Popular Fallacies, Explained and Illustrated. By A. S. E. Ackermann. Third edition. Westminster: The Old Westminster Press. 1923. Price 12s. 6d. net.—This is certainly a most entertaining book and one that is as good for the occasional table as for the study. The author upsets 1350 familiar fallacies, and though only a relatively small number, thank Heaven, occur in the field of engineering, engineers from their human attributes will be just as much interested in others. Some of the fallacies which Mr. Ackermann exposes—always with the help of authorities—had, we hoped, ceased to circulate long since; but, as he shows by quotations from current daily papers that they are still in use, their inclusion is clearly desirable. We can only hope that the book will fall into the hands of those who perpetuate these errors, and particularly into the hands of journalists who have it in their power to correct fallacies. The contents of the volume are divided into twenty-five separate sections and a copious index is provided. The engineering section occupies 147 pages. To give some idea of what it contains we name a few of the errors it corrects. "That high-tensile steel is the strongest material for its weight." "That water divining is usually successful." "That of all substances water has the greatest specific heat." "That a long screw driver *per se* is more powerful than a short one." "That lbs. is the correct contraction of pounds (weight)."

The Engineers' Pocket Technical Dictionary: French-English. By Mark Lvoff. London: E. and F. N. Spon. 1923. Price 3s. 6d.—This is a little volume which can readily be carried in the pocket and which runs to 150 pages. It is intended, so says its preface, "to provide at a small cost, a thoroughly up-to-date technical pocket dictionary, sufficiently complete to enable an English engineer, with a slight knowledge of the French language, to understand French technical words and specifications." It is further explained that most attention has been paid to the expressions used in mechanical and electrical engineering, in the iron and steel industries, and in aeroplane, motor car and cycle manufacture, and it is claimed that while embodying all the ordinary engineering expressions it contains words which cannot be found in other dictionaries. We have checked the dictionary in various directions, and have found it accurate and helpful, and it certainly contains many words not to be found in other dictionaries, especially those comparatively recently coined or adopted in connection with the newer industries of aviation and wireless transmission.

Your Railway Rates. Leeds: The *Yorkshire Evening News*. Paper backed pamphlet of 44 pp., 8in. by 5in. 1s.—This is a reprint of some excellent articles that appeared in the *Yorkshire Evening News*. It puts in clear language the various directions in which the Railways Act is of benefit to the trader and the travelling public. Like all legal enactments, the phraseology of the Act is so involved that the ordinary layman finds it difficult to grasp the whole of its purpose. The Act conferred many favours on the companies, but we have always maintained that the trader gained yet more. A perusal of this useful pamphlet will, we think, support this view. It will show what the benefits are and how, if necessary, they may be obtained.

Institution of Mechanical Engineers.

On Friday evening of last week Professor A. L. Mellanby presented his paper entitled "Clyde Marine Oil Engines," before the Institution of Mechanical Engineers in London. This paper was one of those included in the programme of the Institution's summer meeting in Glasgow, but was not discussed on the occasion of its first presentation. An abstract of it was published in our issue of August 3rd, but since it was written progress has been made, and as delivered on Friday it contained some added information concerning the new type of Beardmore hot-bulb engine. Professor Mellanby's remarks on this engine may be given here in full.

A New Type Beardmore Engine.

An interesting type of engine has just been completed at the Coatbridge works of William Beardmore and Co., the distinguishing features of which are simplicity combined with low fuel consumption. This engine is really a development of the so-called semi-Diesel, and is claimed to possess all the advantages arising from the simplicity belonging to that type, and to approach closely to the Diesel engine in the efficiency of fuel consumption. The engine consists of six cylinders, each 18in. diameter by 24in. stroke, and is rated at 600 brake horse-power when running at 185 revolutions per minute. It is of the two-stroke cycle type, with crank case compression and port scavenging, and has forced lubrication to all bearings including the pump gear. The engine drives all its own auxiliaries, with the exception of the air compressor which provides the starting air. The general features are shown in Fig. 1, where special attention is directed to the piston, the upper portion of which is of aluminium. When the piston is at the bottom of its stroke the cylinder space above is filled with a charge of air. On the up stroke this air is compressed to a pressure slightly over 300 lb. per square inch, and raised to a temperature sufficiently high to ensure ignition of any liquid fuel that may be injected into it. During the same stroke, fresh air is drawn up under the piston into the crank case through light automatic valves. When the crank is near the top dead centre, the fuel charge is injected automatically into the hot air. Combustion takes place very rapidly, almost at constant volume, and the piston is thus forced downwards, giving the power stroke. During this stroke the air below the piston in the crank case is slightly compressed. When the piston is near to the bottom of its stroke, it first uncovers a row of exhaust ports, through which the burnt gases are free to escape. Immediately afterwards it uncovers the scavenge ports, and the compressed air from the crank chamber enters through these, sweeps out the remainder of the products of combustion, and fills the cylinder with the air charge. This forms the complete cycle, which is repeated during each revolution of the engine.

The fuel is delivered to the cylinder on what is now known as the mechanical injection system. No blast air is used, and consequently the usual high-pressure air compressor is not required.

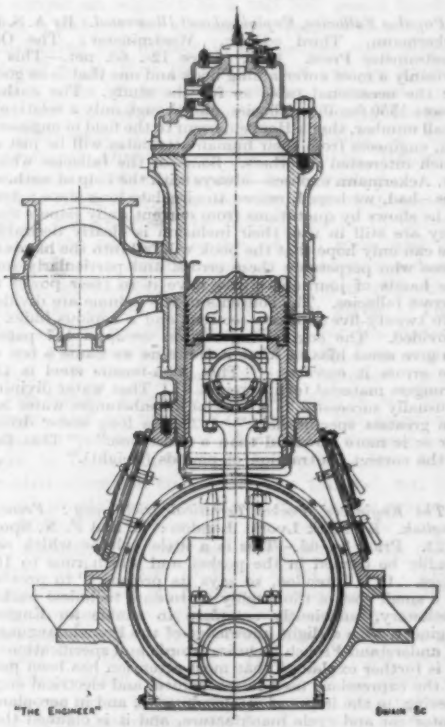


FIG. 1—BEARDMORE 600 B.H.P. ENGINE

Each cylinder is provided with a separate fuel pump, and each pump is operated by an excentric working in phase with the crank of its corresponding cylinder. The fuel is delivered and sprayed into the cylinder through an automatic spring-loaded needle valve atomiser, which is opened by the pressure produced by the pump.

Since the pump driving excentrics are in phase with the cranks, the engine operates equally well in either direction. Reversing is thus a simple matter, and special astern driving mechanism is not required. Starting and manœuvring are carried out by means of compressed air, which is provided by a separately driven compressor. For starting from cold, each cylinder is fitted with an electric plug, which can be heated by current from a battery charged by a small generator on the main engine. This plug heats up very rapidly, and causes the first fuel injections to ignite. Current is then switched off and the engine continues to fire through the heat generated by compression.

The lubrication of this engine has received special consideration, and, contrary to the usual practice with crank case compression machines, the crank shaft bearings have forced lubrication. The oil is delivered at 6 lb. to 10 lb. per square inch to the main bearings. From there it is fed through the shaft to the big end, and thence up the connecting-rod to the gudgeon pin. The pistons and cylinder walls are lubricated by the usual mechanical sight-feed lubricators worked by the engine. Two sets of engines of this type are now being completed by Messrs. Beardmore for installation in a twin-screw boat, the Margretian, of Cardiff. This is a general cargo boat of 6525 tons displacement, 310ft. overall length, designed for a trial speed of 10½ knots. The two engines together will develop 1200 brake horse-power normal rating, but should be capable of heavy overloading. Each engine is 22ft. 0in. in overall length, 9ft. 6in. maximum width, and 7ft. high above floor plates. With flywheel, silencer and exhaust pipes it weighs about 45 tons.

Since the paper was read in Glasgow, the three-cylinder double-acting two-cycle engine, designed by the North British Diesel Engine Works, Limited, Whiteinch, of which a drawing only was reproduced in our issue of August 3rd, has been built and has already run its preliminary trials. The engine is designed to develop 2000 brake horse-power when running at a speed of 100 revolutions per minute. The three cylinders are each 24½in. in diameter with a stroke of 44in. The view given in Fig. 2 shows the engine on the test bed. In the first trial with ordinary fuel valves a consumption of about 0.45 lb. of oil per brake horse-power was obtained over a long run. When the designs are finally completed and certain modifications made this preliminary figure will, it is expected, be considerably reduced. The total weight of the engine is about 200 tons, or, it is claimed, nearly 170 tons less than a four-cycle single-acting engine running at the same piston speed and developing the same power, while there is a saving on overall length of more than 22ft.

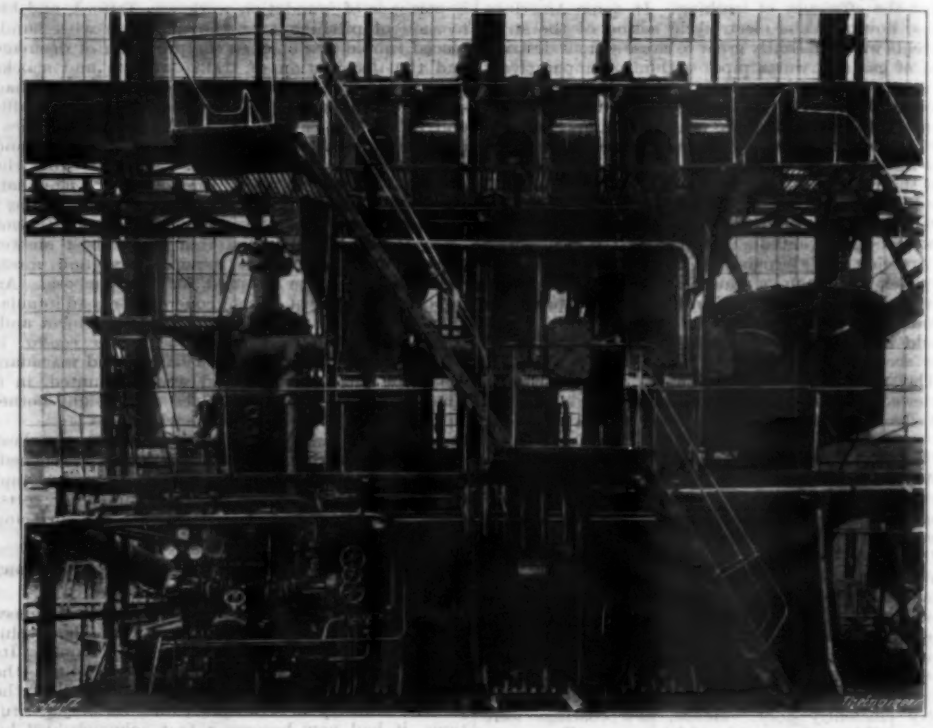


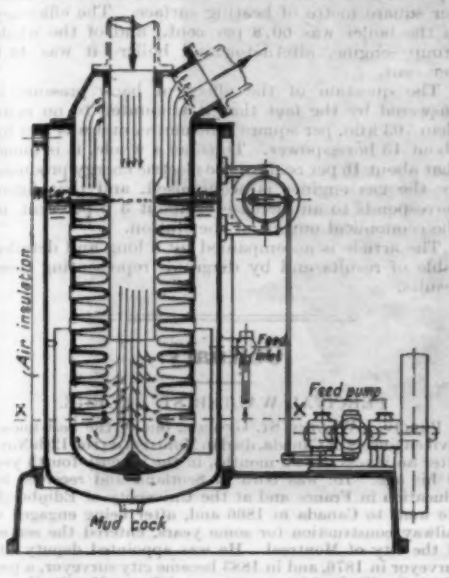
FIG. 2—NORTH BRITISH DOUBLE-ACTING TWO-CYCLE ENGINE

Mr. W. J. Still, who was called upon to open the discussion, said that the 2500 brake horse-power twin set of Scott-Still engines referred to in Professor Mellanby's paper had now been built and tested, and that representing Scott's Shipbuilding and Engineering Company, Limited, of Greenock, he had pleasure in giving some further details of their performance. [These engines were described in the issues of The Engineer for November 23rd and 30th respectively.] In the Scott-Still engine the steam produced from the waste heat was utilised in a novel manner, by being first expanded at the back of one of the main pistons acting as a high-press cylinder, and then passing to a main communicating with the backs of the three remaining pistons which formed in parallel a combined second stage expansion with a 3 : 1 ratio. During its expansion through these two stages the steam fell from a boiler pressure of about 110 lb. per square inch to a vacuum of 20in. The steam was continuously reheated by the pistons and cylinder walls during its expansion, and it appeared to issue from the engine in a slightly superheated state. In this condition it was passed to a steam turbine driving the scavenging blower which formed the third stage of expansion down to a vacuum of 28in. It was evident from the trials made that the two engines running at full power would produce ample steam to drive the turbo-blower without assistance from the stand-by motor to which it was coupled. Further, it had been shown that the steam in passing through the engine developed just about sufficient power to overcome the engine friction. With the fuel oil supply cut off and the brake load removed, the engine would continue to run without any alteration to the steam cut-off. The steam might thus be considered as overcoming all engine friction and also driving the turbo-blower, so that the indicated horse-power produced by the combustion of oil in the top of the cylinder was equalled by the brake horse-power obtained. This condition was approximately correct for full load, but in practice the brake horse-power developed sometimes exceeded the indicated horse-power and at other times fell slightly below it. This condition of a practically frictionless engine, when considered as an internal combustion engine, was, he thought, the cause of the very reduced fuel consumptions obtained. Mr. Still said it was difficult to talk about trial results without anticipating in some way the forthcoming report of the Marine Engine Trials Committee. The figure of between 0.35 lb. and 0.36 lb. of fuel per brake horse-power hour which had recently been published, and which was expected to be obtained under sea-going conditions, was representative of a large number of trials, and did not include any "snap" readings or mere test figure results. Considering that the fuel was injected into the cylinder by direct pressure and that solid injection always tended slightly to penalise an engine as compared with air injection, the performance of the engine might be considered a very creditable one, although he, Mr. Still, did not think it indicated the minimum fuel consumption obtainable with his system. Matters of space and weight and auxiliary equipment had been dealt with at some length in Messrs. Scott's contribution to the symposium on Marine Oil Engines held in January by the North-East Coast Institution of Engineers and Shipbuilders. [See The Engineer for January 19th.] The estimated fuel consumption of 0.37 lb. of oil per brake horse-power for all purposes had been fully justified.

The use of steam and the elimination of compressed air had done much to simplify the auxiliary machinery, and apart from the main engine, the engineers in charge would have little to look after and keep in order. The tendency in Still engine development was towards a further reduction in the number of auxiliaries, and a possible elimination of the expensive and intricate Diesel-electric installation which was now found on many motor ships. A charge of complexity had been levelled against the Still system, because it had sought to combine the steam engine with the internal combustion engine. In a modern motor ship the machinery comprised not only the main oil engines, but also auxiliary oil engines for electric lighting, power and compressed air electric motors, switchboards, air starting and storage receivers, and a steam boiler, with its auxiliary plant. It would seem certain that a steam-combustion installation, such as the "Still," with steam standby plant and deck machinery, along with a small electric lighting installation, would prove a simpler machinery installation to build, to use, and to keep in repair. As long as standby machinery was only intermittently used, its low efficiency had but little effect on the yearly fuel bill, and the use of steam winches was, to a large extent, justified by the same argument, namely, that of the small number of hours per annum during which they were in active service and the very little steam used per annum.

Mr. Thomas Clarkson gave some very interesting details regarding some experiments which he had made in the recovery of waste heat from the jacket water and exhaust gases of an 84–90 brake horse-power Vickers-Petter two-stroke cycle engine. The object sought was not the generation of steam, but the heating of water for the purpose of supplying baths, &c. Close attention, Mr. Clarkson said, was, from the outset, given to the design of the boiler

and especially to securing the condition that it should be possible to arrange it very close to the engine in order to avoid loss of heat by radiation, &c., from the connecting pipes. The boiler employed was of the thimble tube type, which Mr. Clarkson has developed for coke-fired motor vehicles and similar purposes. Its design will be gathered from Fig. 3 while in Figs. 4 and 5 its position relatively to the engine is shown. In the actual application the boiler was used in the inverted position. The thimbles projecting from the water space into the hot gas chamber are, as shown in the plan, staggered in such a way as to cause the rapid removal of the gases from the heating surfaces after they have given up their heat and become cooled. The boiler is provided with a float control, whereby the water level is automatically regulated. In the trials carried out, the temperature of the exhaust gases leaving the engine, as measured by a mercury thermometer and checked by a thermo-couple, was, Mr. Clarkson stated, found to be 580 deg. Fah. After passing through the boiler the temperature of the gases showed a fall of about 300 deg. The cooling water entering the jackets had a temperature of 54 deg.,



Sectional plan on line X. X.

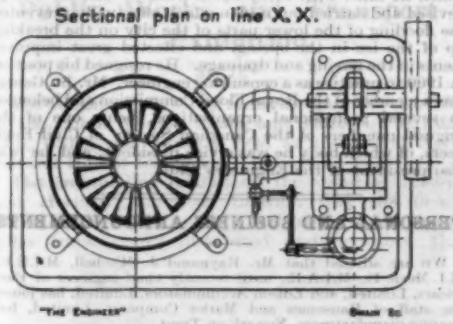


FIG. 3—CLARKSON THIMBLE-TUBE BOILER

and was raised to 125 deg. in the exercise of its function. From that temperature the boiler raised it to 165 deg., when the whole of the jacket water was sent through the boiler. By by-passing some of the jacket water the temperature of the supply delivered from the boiler could be raised to any desired figure. At the boiling point the quantity of water sent through the boiler was 26 cwt. per hour. By these means from 50 to 60 per cent. of the waste heat was recovered. The boiler, Mr. Clarkson added, proved, incidentally, to be a very effective silencer. After prolonged use some heavy carbon deposit was found on the outside of the thimbles, but it was quite easily removed by burning it off, a procedure rendered possible without causing the thimbles to leak by virtue of the factthat the thimbles were held only at one end.

The question of back pressure was not mentioned at the meeting, but Mr. Clarkson has informed us that although it was anticipated by some that the presence of the boiler might cause considerable back pressure on the engine and a consequent increase in the fuel consumption or a decrease in the brake horse-power, the tests showed quite a different result. Actually, the fuel consumption, he tells us, was found to be slightly less per brake horse-power with the boiler than without it. In explanation of this somewhat curious fact, Mr. Clarkson mentions the sudden chilling of the exhaust gases at a point close to the engine, and the shrinkage of volume which naturally accompanies the drop in temperature of about 300 deg.

Captain H. Riall Sankey referred to the tests which he made on the Scott-Still single-cylinder experimental engine—see THE ENGINEER for February 16th, 1923—about the same time as those made by a French Commission on the same engine. There were difficulties connected with the testing of the single-cylinder engine which did not occur with the multi-cylinder units. From the tests made he was able to deduce the figure of 0.353 lb. of oil per brake horse-power at full load, which, when various points had been cleared up, would, he felt, be found to be on the right side.

Mr. L. A. Legros, a member of the Committee appointed by the Institution and the Institution of Naval Architects to conduct the recent tests on the Still engine at Greenock, compared the conditions of engine-testing nowadays with those which prevailed in the steam trials of 1890–92. He emphasised the fact that it was now possible to obtain information concerning the behaviour of an engine on test much more quickly, accurately and completely than was the case in former years, and added that the two Institutions, through their Marine Oil Engine Trials Committee, were now engaged in contributing very greatly to our knowledge of both engine and propeller.

Mr. Adamson dealt with the questions of lubrication and the tightness of piston rings. Cylinder lubrication was a very important factor, and if economy was to be obtained, the oil must be delivered in correct quantities at the proper time. The amount of oil necessary for the cylinders had been found to be about one-third of that required on the whole engine, or from 2 to 6 gallons per day of 24 hours for an engine of 3600 brake horse-power. There appeared to be a large variation in the amount of lubricant used. The quality of oil was also important, but there appeared to be several reliable brands. With regard to piston rings, it had been found advisable to round off the top edges of the rings so as to assist in the formation of an efficient oil film. The end clearances of piston rings were fully as important as the side clearances. Interesting particulars on this subject were given by Mr. John Lamb in a paper on "The Operation of Marine Diesel Engines," read before the Institution of Marine Engineers last spring.

Mr. W. A. Tookey expressed great interest in a diagram given in the paper showing the results of a series of tests on a four-stroke cycle air-injection engine, the diagram taking the form of the mean effective pressure plotted against the percentage volume of oxygen in the exhaust gases. The diagram, he said, confirmed the view that a mixture much stronger than one showing 42 B.Th.U's. per cubic foot could not be used without the efficiency suffering. For the Still engine, he added, it was stated that test results gave a figure of 0.35 lb. of fuel per brake horse-power. He himself had recently tested a solid injection Ruston engine and had recorded a consumption of 0.386 lb., and that with but a small engine, one not much larger than 100 horse-power.

Mr. W. H. Patchell, who, in the absence of the President, occupied the chair, in calling upon the author to reply to the discussion, remarked that in the recovery of waste heat from internal combustion engines, we in this country appeared to be progressing more rapidly than were engineers in the United States.

Dr. A. L. Mellanby said that various contributions, especially Mr. Still's extended description of his engine, had added useful information. The remarks did not call for much criticism, but he would reply briefly to some of the points raised. The use of Diesel-electric or steam auxiliaries on a motor ship opened a disputed question. He had talked with owners who would not have electric auxiliaries at any cost, and others who would install nothing but electrical auxiliaries on their ships. There was a divided opinion, and more information might usefully be given. Mr. Robert Love had recently given an interesting paper on "Auxiliary Machinery for Motor Vessels" before the Institution of Engineers and Shipbuilders in Scotland. Mr. Clarkson had described an extremely interesting waste heat boiler of reasonable size. He would like to ask Mr. Clarkson whether the temperature of the gases entering the boiler as calculated from the amount of heat given up bore any exact relation to the gas temperature as measured by the thermometer or pyrometer. He believed that the actual temperature of the gases was considerably higher than that shown by thermometer readings. Referring to the Manchester experiments of Dr. Nicholson, it would be remembered that the rate of heat transference was proved to be dependent on the rate of flow of the gases over the surface. The area of heating surface could be reduced by increasing the speed of the gases. Following on the lines of the experimental work which had already been done, he had been able to design a waste heat boiler which could be placed within the exhaust pipe of the 35 horse-power Mirrlees Diesel engine, installed at the Laboratory of the Royal Technical College in Glasgow.

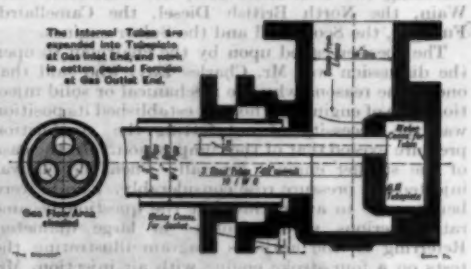
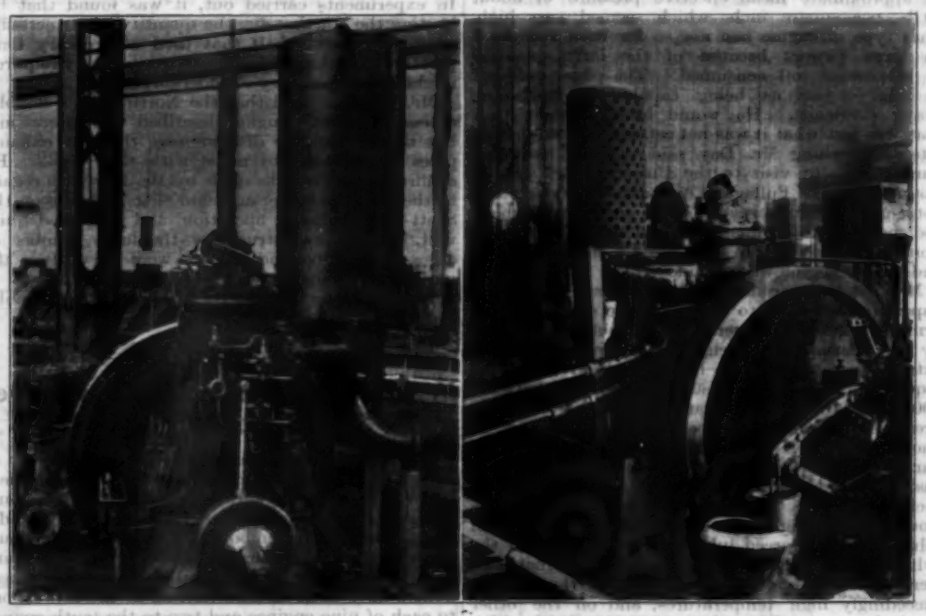

The Internal Tubes are expanded into Tubeplate at Gas Inlet End, and work in cotton packed Ferrules at Gas Outlet End.
Gas Flow Arrangement

FIG. 6—MELLANBY EXHAUST GAS BOILER

The 4in. exhaust pipe was replaced by a 3in. pipe, in which three 1in. water tubes were placed. An illustration of one end of this boiler is shown in Fig. 6. The gases passed at a high velocity, and results showed that the heat recovered was in accordance with what might be expected from the scientific experiments which had been carried out. The important design coefficient was found to be a gas speed term in the form of the mass flow divided by the area of flow. In the case in question the value of this term was about 4 in lb./sec./square feet units. Such a value was many times greater than that found in the ordinary type of boiler. Such lines of development would undoubtedly lead to considerable reductions being made in the size of waste-heat boilers. Mr. Legros had mentioned the old marine engine trials. It was a pleasure to have Mr. Legros as a colleague on the present trials. Mr. Tookey had referred to the curve in the paper which showed the percentage volume of oxygen present in the exhaust gases at different indicated mean effective pressures. A proper analysis of the exhaust gases formed a much better basis for calculations of volumetric efficiency and the amount of air taken into the cylinder than the figures obtained by using volumetric air measuring devices.

The Haldane method of analysis or a similar method in the hands of an expert gave eminently satisfactory results. With regard to Mr. Adamson's remarks on lubrication, he, Dr. Mellanby, agreed fully that care had to be taken both with the quantity and quality of lubricating oil used.

In conclusion, it should be stated that marine oil engines were absolutely reliable in operation. In



FIGS. 4 AND 5—CLARKSON BOILER ATTACHED TO VICKERS-PETTER ENGINE

the case of the motor ships Pinzon and Pizarro, engined with Beardmore Tosi machinery and engaged in the Spanish fruit trade, recent voyages had shown that reliability and maintenance of a high speed of revolution in the worst possible weather were characteristic features of the vessels. The engineers running these ships spoke highly of the plant in their charge. The main engines which were now being built held out the possibility of important developments later.

The paper was also discussed in Manchester on the preceding evening. The chair was taken by Mr. Alfred Saxon, chairman of the branch. In his introductory remarks the author said that requirements of weight and space were causing engineers to depart from the conventional designs, and that the engines now being put into service must be regarded as illustrating the first phase of the application of the oil engine to sea-going conditions. He then proceeded to describe briefly the principal features of the engines now under construction on the Clyde, including the Beardmore-Tosi, the Burmeister and Wain, the North British Diesel, the Camellaird-Fullagar, the Scott-Still and the Sulzer engines.

The speaker called upon by the chairman to open the discussion was Mr. Charles Day, who said that one of the reasons why the mechanical or solid injection type of engine had not yet established its position was the necessity of not letting the combustion pressure exceed that of the compression. In the case of the smaller engines generally when the oil was injected the pressure rose considerably. Efforts were being made to avoid this, but the question became rather serious with cylinders of large diameter. Referring to the author's diagram illustrating the tests on a four-stroke engine with air injection, Mr. Day pointed out that the curve showed that as the oxygen in the gases was reduced the rate of increase of mean effective pressure diminished, showing that all the time the thermal efficiency of the engine must be falling. Mr. Day said that in American Diesel-engine works built-up crank shafts were being extensively adopted, the difficulty of the short strokes mentioned by Dr. Mellanby being overcome by making the two webs and pins in one piece. In some cases cast steel was used, as it was held to be more reliable than forged steel. He said that the director valve referred to in the paper was not new. It had been tried on gas engines and proved a failure, because after the inlet stroke the space between the director valve and the main valve remained full of gas mixture, and when the exhaust was opened the mixture flowed into the cylinder, resulting in a loss of gas. That would not occur with an oil engine.

Referring to the appendix, Mr. Day expressed surprise that the type of engine referred to had an approximate mean effective pressure of about 60 lb. per square inch, which seemed very high. That type of engine had not so far been successful on large powers because of the large quantity of lubricating oil consumed. The paper referred to this engine as being capable of sustaining heavy overloads. He would have thought that that was just what it was not capable of doing. One interesting thing Mr. Day said that he had seen during a recent visit to the United States was an example by the Fullagar Company of 400 and 500 horse-power engines geared on to one central wheel, the speed of which was reduced down to 80 revolutions per minute. In that way a much cheaper and lighter engine was obtained.

Mr. Newton considered that Professor Mellanby's paper was a tribute to the enterprise of the leading firms of marine engineers. The problem presented by the marine Diesel engine was, he said, one of extreme complexity. It had the disadvantage of requiring a maximum pressure of somewhere between 500 lb. and 1000 lb. per square inch to achieve a mean pressure of about 100 lb. per square inch. That at once threw very severe stresses on all the engine parts, on the crank shafts and bearings, and in the case of the four-cycle engine those stresses were of a racking nature. The difficulty with the bearings would, he thought, probably hardly have been soluble but for forced lubrication. Coming to the cylinder, the demands made on the materials were severe, for, on the one hand, there were exceedingly high temperatures, and on the other hand, those temperatures were accompanied by high stresses. At the same time, it was necessary to have very tight-fitting joints in order to keep down leakage of hot gases at high pressure. It would, continued Mr. Newton, have added much to the value of the paper if Professor Mellanby had seen his way to give some comparative figures of the weight, the horse-power, and the consumption which was achieved in actual service.

Mr. Kersey said that the relation of mean pressure to the composition of the gases was a very interesting subject. He preferred to put the information in rather a different way—the relation of the mean effective pressure to what most people called the air gases ratio. In that case, taking the data of the paper, he got a rather interesting relation between the mean effective pressure and the air gases ratio—

$$p = \frac{120}{r} + 30.$$

The relation, he said, was interesting, because the thermal efficiency was a function of the air ratio in that case. The question of mechanical efficiency was rather important in comparing the Scott-Still engine with the Fullagar. He had worked out the mean effective pressures from a few instances given in the paper. The Fullagar had a mean effective pressure of about 66; the Scott-Still, from the information on page 722, had a brake mean effective pressure of about 80.

Mr. Orton, quoting from a paper which was read before the German Engineering Society in July last, said that, generally speaking, in Germany there was the same variety of designs as on the Clyde. Perhaps the most ambitious thing that was ever done in Germany was the building of a 12,000 horse-power engine. It was rather remarkable, but there were, in Germany, six years ago, two engines of 12,000 horse-power which actually ran, and carried out, sufficiently successful tests. They were built primarily for the Government, and they were intended to be put into battleships. Those engines were begun in 1910, and were finished in 1917. One built by the M.A.N. Company had six cylinders, 850 mm. diameter, and developed 12,000 horse-power. The system of scavenging in that engine was valve scavenging. That 12,000 horse-power engine was submitted to long tests in the early part of the year, and one of the tests included a five days' non-stop run. Owing to the fact that it could not be loaded any more than 12,000 horse-power, and in order to find out what the absolute capacity of overload of the engine was, one cylinder was taken off and tested to the maximum power; 3200 horse-power was got from it, and the mean effective pressure was 147 lb. to the square inch. The latest double-acting engine was built by the M.A.N. Company, which had built an experimental two-cylinder engine of 1600 horse-power, i.e., 800 horse-power per cylinder, but on somewhat different lines, and it had followed the general practice, which seemed to be adopted nowadays, of port scavenging instead of valve scavenging. In that respect, too, the makers had struck out on a line of their own—they had the exhaust ports above the scavenging ports. In this engine, the air was directed downwards on to the crown of the piston, up the other side, and out at the bottom again, just above the exhaust pipes. In the paper referred to, in connection with scavenging of two-stroke engines, there were some interesting curves given for both this particular engine and for an ordinary Sulzer-type two-stroke engine. Mr. Orton said that in the Sulzer engine, at the end of the scavenging period, the contents of the gases in the cylinder contained over 20 per cent. of oxygen, and in the case of the two-stroke double-acting engine, the contents were between 19 and 20 per cent. Mr. Orton also mentioned that German firms were using hot air for manœuvring purposes. In experiments carried out, it was found that by heating the starting air, the quantity of air actually used was exactly half that used at ordinary temperature. That showed that the air capacity required might be reduced very considerably.

Mr. Windeler said that the North British double-acting two-stroke engine described was interesting, but that it had the disadvantage that the exhaust pipes would have to move with their units. He confirmed the remarks made by Mr. Day with regard to the director valve, and said that he had seen the Scott-Still engine in operation, and it worked quite well, but he was struck by the large number of accessories. Such accessories were very often the most troublesome part of a power plant.

After a few remarks by the chairman, Dr. Mellanby replied to the discussion.

Waste Heat Recovery in a Power Station.

We find in the November issue of the *Revue de Métallurgie* an account of some tests of a waste heat boiler. These tests were made in the power-house of the Belval works of the Société Métallurgique des Terres-Rouges (Luxembourg). In this power-house there are ten blast-furnace gas engines, developing in all 15,400 kilowatts. Since 1922 eleven waste heat boilers have been in use—that is, at the rate of one to each of nine engines and two to the tenth engine, which is a twin tandem. It has been found that 1.1 kilos. of steam can be generated from the waste heat per kilowatt-hour. By using this steam in a turbine, about 16 per cent. of the kilowatt-hours produced by the gas engines is saved, or, to put it another way, the power generated for a given quantity of gas is increased by 16 per cent. It has been found also that the thermal efficiency of the gas engines is increased, owing to the manner in which the turbine is used.

The trials were carried out in November, 1922, on a M.A.N. gas engine coupled to an alternator. The engine is of the four-cycle double-acting tandem type, with cylinders 1.15 m. by 1.3 m. The waste heat boiler was made by the Dingler'sche Maschinenfabrik. It is horizontal, has a heating surface of 120 square metres, an economiser of 60 square metres, and a superheater of 15 square metres. The tests were very full and observations were made every ten minutes for varying periods on different occasions, the shortest run being one hour and the longest two hours and a-half. Five tests were carried out with the alternators working against a water resistance and one test under normal load.

The mean calorific value of the blast-furnace gas varied between 837 and 897 calories per cubic metre—say, 95 to 100 B.Th.U. per cubic foot—but to make all the results comparable, the figures were reduced to equivalence with gas at 900 calories per cubic metre. The gas engines run at the highest economy when developing 2460 horse-power, or 1465 kilowatts at the slip-rings of the alternator. At this output the consumption of gas was 2.33 cubic metres per horse-power hour. The thermal efficiency of the engine was 30.2 per cent. at full load and 8.7 per cent. when running light. The best efficiency for the generator set, taking the efficiency of the alternator as 81 per cent., was 24.5 per cent.

The highest temperature of the exhaust gases was 574 deg. Cent., and their pressure fell from 300 mm. of water at their entry to the waste heat boiler down to 20 mm. at their exit. The highest hourly production of steam was 1570 kilos. at 340 deg. Cent., equivalent to 1800 kilos. "from and at," or 10 kilos. per square metre of heating surface. The efficiency of the boiler was 60.8 per cent., and of the whole group—engine, alternator and boiler—it was 46.9 per cent.

The question of the effect of back pressure is answered by the fact that it amounted to no more than .03 kilo. per square centimetre, and was met by about 15 horse-power. Thus, as a whole, it is found that about 16 per cent. of the electric energy produced by the gas engines is economised, and that figure corresponds to an increase of about 3.5 per cent. in the economical output of the station.

The article is accompanied by a long and detailed table of results and by diagrams representing these results.

Obituary.

PERCIVAL WALTER ST. GEORGE.

PERCIVAL WALTER ST. GEORGE, one of the best-known civil engineers of Canada, died in Montreal on the 12th Nov., after an illness of two months, in the seventy-fourth year of his age. He was born in Scotland and received his education in France and at the University of Edinburgh. He went to Canada in 1866 and, after being engaged in railway construction for some years, entered the service of the city of Montreal. He was appointed deputy city surveyor in 1876, and in 1883 became city surveyor, a post which he filled with conspicuous ability. Mr. St. George devised and carried out a plan which effectually prevented the flooding of the lower parts of the city on the breaking up of the ice in the spring, and effected great improvements in the paving and drainage. He resigned his position in 1900 to practice as a consulting engineer. Mr. St. George was a member of the Royal Flood Commission and belonged to several professional organisations, being one of the original members of the Canadian Society of Civil Engineers, of which body he was a vice-president, and he was also president of the Engineers' Club.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are advised that Mr. Raymond J. Mitchell, M.I.E.E., M.I. Mech. E., M.I.A.E., until recently chief engineer of Electricars, Limited, and Edison Accumulators, Limited, has joined the staff of Ransomes and Marles Company, Limited, ball bearing manufacturers, Newark-on-Trent.

CONTRACTS.

THE VICKERS-SPEARING BOILER COMPANY, Limited, of 20, Kingsway, W.C. 2, has just secured a contract for the second section of extension of generating plant, consisting of four large water-tube boilers of the Spearing type, for the Leicester Corporation electricity works.

GILBERT LODGE AND CO., Limited, of Collins-street, Melbourne, through whom Elliott's Metal Company, of Birmingham, secured some time ago an order for 600 tons of copper wire, have recently secured a contract for the supply to the Commonwealth Post Office Department of 500 tons of copper wire and 180 tons of galvanised iron telegraph wire.

BRITISH EMPIRE EXHIBITION.—Hours of opening and closing the British Empire Exhibition, which starts at Wembley next April, have now been fixed. The Exhibition grounds will be open from 10 a.m. to 11 p.m., except Sundays. Exhibits will be on view from 10 a.m. to 10 p.m. No exhibitor will be required to keep any machinery moving or full staff in attendance at stalls after 8.30 p.m. from Mondays to Fridays inclusive, or after 9.30 p.m. on Saturdays, but otherwise exhibitors will be expected to keep their exhibits fully on show between 10 a.m. and 10 p.m. In regard to sales, exhibitors will be permitted to arrange their own hours between 10 a.m. and 10 p.m., subject to the provision of the Shop Hours Act.

WORLD POWER CONFERENCE.—We are informed that the names of several distinguished contributors, on subjects of outstanding importance, have been added to the programme of the World Power Conference, which is to be held at the Exhibition next summer. The Finnish Government has appointed as its representative the Engineer-in-Chief of its Water Power Department, Mr. Hugo Malmi. Mr. Malmi will present a paper on "The Power Resources of Finland." Dr. C. H. Lander, of the Fuel Research Board, will contribute a "National Survey" on his special province; while Sir George Beilby, F.R.S., LL.D., member of the Advisory Council on Scientific and Industrial Research, will present a "National Survey of Oil Resources." "The Winning and Utilisation of Peat," a subject of considerable economic importance, will be dealt with by Professor Pierce Purcell, of University College, Dublin, who is one of the leading authorities on this subject. The combustion of powdered coal in rotary cement kilns is to have a place in the programme. It will be handled by Dr. G. Martin, of the British Portland Cement Research Association.

TANDEM MOTOR ROAD ROLLER

RUSTON AND HORNSBY LIMITED, LINCOLN, ENGINEERS

FIG. 7

Public Works and Transport Exhibition.

No. II.*

WE continue below our remarks upon the exhibits at the Public Works, Roads and Transport Exhibition, which was recently held at the Royal Agricultural Hall at Islington.

The outstanding exhibit on the stand of Ruston and Hornsby, Limited, Lincoln, was the firm's No. 6 crane navvy, which was mounted on caterpillar tracks. We illustrated and described this machine in our issue of May 18th last and there is, therefore, no call to describe it at length in the present instance. It may be said, however, that the motive power is steam, and the working pressure 125 lb. per square inch. There are three engines: (*a*) The main engine, with cylinders 5in. by 6in., which operates the hoisting and travelling motions; (*b*) the racking engine, with cylinders 4in. by 5in.; and (*c*) the slewing engines, also having cylinders 4in. by 5in. The bucket capacity is from 7 to 8 cubic yards, and pressure up to 6 tons can be put on the cutting teeth. The maximum radius of discharge is 24ft.

Another exhibit which attracted our attention was a tandem road roller, which is driven by a two-cylinder vertical paraffin engine, fitted with a high-tension magneto. It is illustrated in Fig. 7. This machine is a development of the motor road roller which has already been described in our columns, a leading difference between it and the model previously dealt with being the fact that it has tandem rollers. The weight of the machine exhibited was given as being 8 tons. Actually, it weighs, empty, 7 tons, and in working order 7½ tons, though, as provision is made for water-ballasting the hind roller, the weight may be increased, if desired, up to a maximum of 8½ tons. The horse-power of the engine is 20, and there are three speeds, *i.e.*, 2½ miles, 1 mile and ½ mile per hour. There are two clutches on the gear-box, so that the direction of travel can be reversed instantly, which is, of course, an attribute of great importance for asphalt, bitumen, or tar compound work, since there is no "rest," or pause for changing the gears. Incidentally, it is pointed out, there is the added advantage of absence of wear and tear on the gears which is caused by frequent engagement and disengagement, since it is not necessary to disengage any gears when reversing. The front roller, which is made in two halves for ease in steering, is 3ft. in diameter and 3ft. wide, the hind roller being 3ft. 6in. in 4ft. in diameter. The engine is arranged longitudinally in the frame, and the drive is taken from it to the gear-box through a short shaft, which is furnished with disc couplings at each end. The final transmission to the rollers is by enclosed roller chain. The driving mechanism can, when required, be entirely disconnected from the rollers and the engine employed for driving a pulley 18in. in diameter by 6in. face at maximum speeds of 150 or 286 revolutions per minute.

The construction and operation of the tar-macadam mixer exhibited by Ord and Maddison, Limited, of Darlington, will be well understood from the drawing of the machine which is given in Fig. 8. It is mounted on wheels so that it is portable and it requires 10 brake horse-power to drive it. The skip is self-loading and measures the charge, which may be from 8 cwt. to 10 cwt. per batch. The mixer body, which is steam jacketed, measures 4ft. 6in. long by 3ft. wide, and the mixing is performed by means of revolving paddles, which, when the mix is complete and the discharge door at the bottom of the mixer trough opened, scrapes out the whole of the charge, so near do the

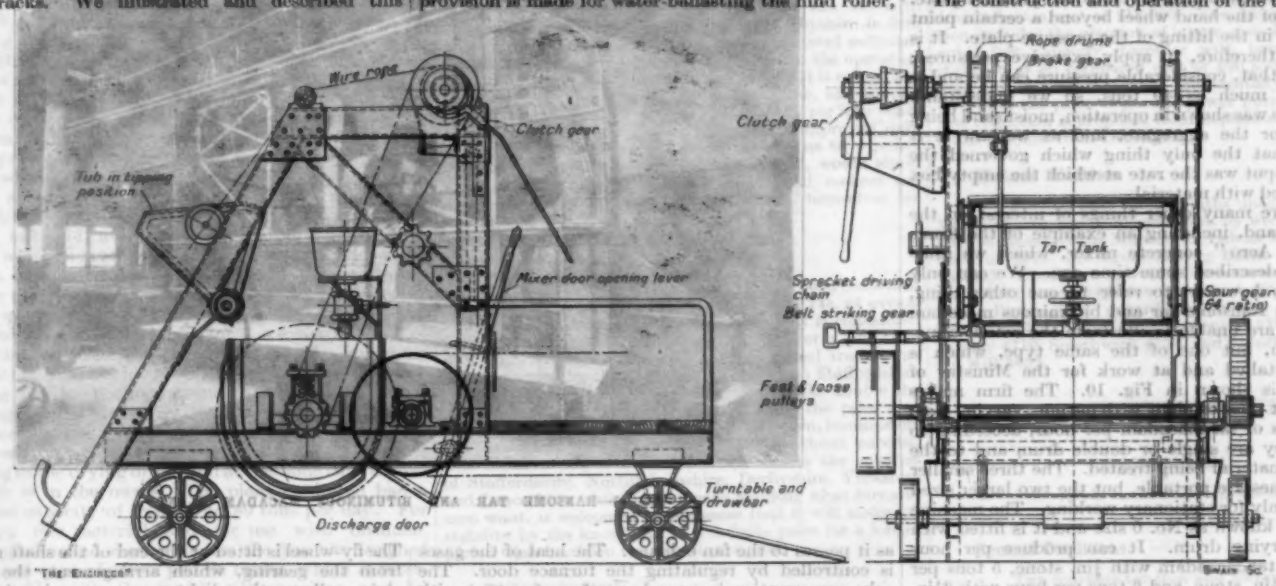


FIG. 8—ORD AND MADDISON TAR-MACADAM MIXER

* No. I. appeared November 30th, 1923.

scrapers reach to the sides and bottom of the trough. The machine has a capacity of from 10 to 12 tons per hour.

One of the exhibits on the stand of Ransome Machinery Company (1920), Limited, which was attracting a considerable amount of attention was a concrete or clay moulding machine which, its manufacturers claim, makes "almost anything"—an accurate claim if it be added that the overall dimensions do not exceed 18in. by 9in. by 9in. The machine—which is shown in operation in Fig. 9—has three moulding boxes, which are mounted on a low revolving frame. The idea is that while one box is being filled

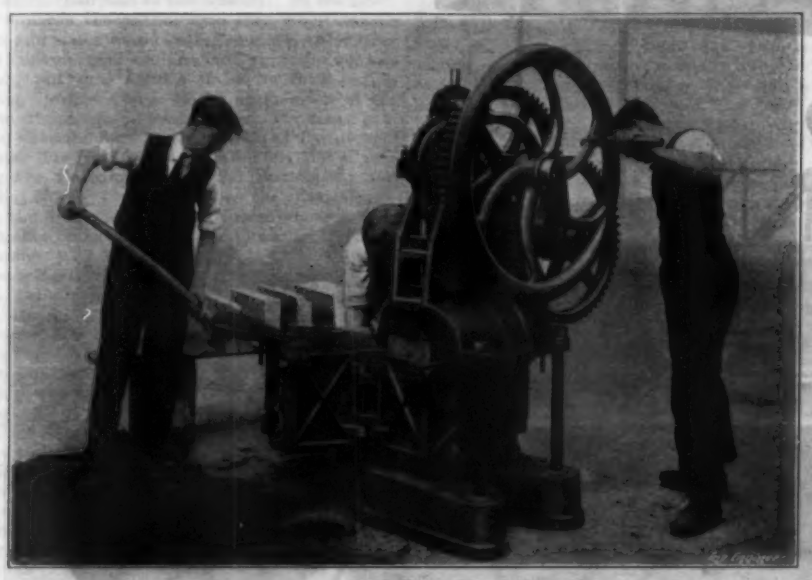


FIG. 9—RANSOME CONCRETE OR CLAY MOULDING MACHINE

the next box to it is being pressed, and at the same moment the finished product is being removed from the third box. By the employment of a number of different lining blocks the machine can be made to produce solid or hollow, plain or ornamental blocks, bricks, slabs, copings, angles, &c., in innumerable shapes and sizes up to and including the dimensions mentioned above, as well as pin and pantiles and clay bricks. The ends and outer side of the box, which are, when the boxes are being filled or pressed, held in position by means of hinged bolts and wing nuts, can be hinged down so that the removal of the products is easy. The pressure is brought to bear by means of an excentric and plunger rod, the lower end of which is connected to the top of the pressure plate. The excentric is revolved through double reduction gearing by means of a heavy hand wheel which acts as a fly-wheel. The advantage of the excentric arrangement is, of course, that no more than a certain amount of travel can be given to the pressure plate. Revolution of the hand wheel beyond a certain point only results in the lifting of the pressure plate. It is impossible, therefore, to apply excessive pressures; but, for all that, considerable pressure can be and is applied—as much as 40 tons, so we understand. The machine was shown in operation, moist sand being employed for the aggregate, and as we saw it it appeared that the only thing which governed the speed of output was the rate at which the empty box could be filled with material.

There were many other things of interest on the Ransome stand, including an example of the firm's ingenious "Aero" concrete mixer, which we illustrated and described some time ago. We can only spare space, however, to refer to one other thing, namely, the Ransome tar and bituminous macadam plant. We are unable to illustrate the actual apparatus shown, but one of the same type, which is actually installed and at work for the Ministry of Transport, is shown in Fig. 10. The firm makes five different sizes of plant with outputs varying from 3 to 24 tons of tar-macadam per hour, according to whether they are single or double drum and to the size of the material being treated. The three smaller sized machines are portable, but the two larger sized plants are only for stationary working. The machine exhibited is known as No. 0 size and it is fitted with a double drying drum. It can produce per hour 4.5 tons of tar-macadam with ¼in. stone, 5 tons per hour with 1½in. stone, and 6 tons per hour with 2½in. stone, the bituminous macadam figures being up to about 25 per cent. less than the quantities given. The outputs quoted are based on an aggregate weighing 100 lb. per cubic foot, and a delivery of one batch every 2½ minutes.

The essential parts of the machine are:—(1) The elevating skip; (2) the drying drum or drums; (3) the furnace; (4) the flue and fan; (5) the mixer; (6) the driving pulley and gear; and (7) the underframe, which also forms the operating platform. In operation the aggregate to be dried is either fed by chute direct into a fixed measuring hopper or shovelled or tipped into the skip, which measures a definite batch. The skip is hoisted by power, strikes an automatic knockout gear, and discharges its contents into a fixed receiving hopper, from which the batch is passed into the drying drum or drums, as the case may be. When all the moisture has been evaporated and the aggregate heated to the required temperature the charge is passed by hand lever into the mixer, from which, after being coated with the hot binder that is poured in, the whole batch is discharged into a receptacle beneath. The coating process can be watched while it is going on. As soon as one batch is coated the succeeding batch is dried and ready to be shot into the mixer and the sequence of operations is continuously repeated. The time required to pass a batch through the plant necessarily varies according to the size and nature of the aggregate, the degree of moisture it contains, the temperature to which it is to be heated, and its affinity for the binder, but from two to three minutes per batch is, the makers state, usually sufficient for their plants.

For drying the stone a fire-brick-lined furnace burning coke under a fan-induced draught is employed. The heat-stream passes directly by flue into the drying drum, which latter is furnished with specially formed blades that pick up the stone and scatter it in small spread-out showers right through the heat-stream as it passes to the fan exhaust. The heat of the gases is controlled by regulating the furnace door. The coke consumption in pounds per ton of output with different percentages of moisture for tar-macadam, bituminous macadam, and asphalt is given as being as follows:—

	Percentages of moisture.		
	3	2	1
Tar-macadam	19	16	13
Bituminous macadam	22	19	16
Asphalt	27	24	24

When asphalt is being used special mixing paddles are needed and the plant is arranged to run at a higher speed than is necessary for the other binders.

Broom and Wade, Limited, had two extensive exhibits, one in the Main Hall, and one in the Gilbey Hall. Both were confined to power-driven air compressors and to tools used for breaking up concrete. The machines were arranged to be driven by steam, petrol, or crude oil engines, and they varied in capacity from 40 to 600 cubic feet of free air per minute at pressures up to 100 lb. per square inch. The Broom and Wade, or "Broomwade," reciprocating compressor is well known to our readers, and we need not, therefore, discuss it in detail, merely remarking, in passing, that, for those unacquainted with its mechanism, there was a sectional compressor operating slowly, so that the movement of piston and valves could be easily studied. Although the compressor does not call for description, however, attention may well be drawn to the portable sets which were driven by crude oil engines. There were two of them, one designed to deliver 120 cubic feet of free air per minute at a pressure of 100 lb. per square inch, and the other 58 cubic feet of free air per minute at the same pressure. We believe that two other sizes of these machines are built, namely, those delivering 86 and 180 cubic feet of free air per minute. The motive power in each case is furnished by crude oil engines, built by Petters, Limited, of Yeovil, and we understand that the combined sets have been particularly successful. The compressor in the 120 cubic feet sized machine has twin cylinders, 7in. in diameter by 5½in. stroke, and the two-cylinder engine driving it is designed to develop from 24 to 28 brake horse-power at 525 revolutions per minute. The complete unit, which includes an air receiver, is mounted on a steel channel base, which is furnished with cast steel road wheels with a swivelling forecarriage, brakes, &c. There are two radiators, one for the engine, and one from the compressor, and the fan, which runs on ball bearings, is belt-driven, with a jockey pulley for adjusting the tension of the belt. We have several times referred to the "Petter" crude oil engine, and it is not, therefore, necessary to describe it again now, but need only say that it is fitted with the maker's patented cold-starting device, which enables it to be started at once from the cold without the use of a blow lamp, or any other external device. This size of machine is capable of operating from five to six road breakers, and the makers claim that the fuel cost for delivering 118 cubic feet per minute at 100 lb. per square inch continuously for 8 hours, is only 6s. The smaller set can operate from two to three road breakers. One of the sets was shown in operation, boring holes in hard material.

Reference may also be made to the "Broomwade" patented "Typhoon" self-contained enclosed gear-driven compressor, which was also on view. In this machine, the double helical gearing, which is furnished with Hyatt roller bearings, is enclosed, and is integral with the base of the compressor. The stresses in the gears usually set up by twisting of the bed-plate or frame are, in this machine, eliminated because the compressor and gearing are both self-contained.

FIG. 10—RANSOME TAR AND BITUMINOUS MACADAM PLANT

The fly-wheel is fitted at the end of the shaft removed from the gearing, which arrangement, the makers claim, allows the slight unevenness in the cyclic variation to be taken up by the spring of the crank shaft, with the result that the running is perfectly smooth and silent.

While on the subject of compressors, attention may be drawn to a wonderfully neat little portable electrically driven compressor which was exhibited among a number of other interesting things by Reavell and Co., Limited, of Ipswich. As will be seen from the illustration which we give of it in Fig. 11, it is a remarkably compact little plant. The compressor has two unjacketed cylinders which have a piston displacement of 65 cubic feet per minute at a speed of 500 revolutions per minute, and is de-

signed for a working pressure of from 80 lb. to 100 lb. per square inch. One of the duties for which the plant is evidently intended is the breaking up of concrete under tramway rails, for the motive power is derived from a small entirely enclosed tube-ventilated electric motor, which is wound for 550 volts, and we are informed that no starting switch is necessary, the full voltage being applied direct to

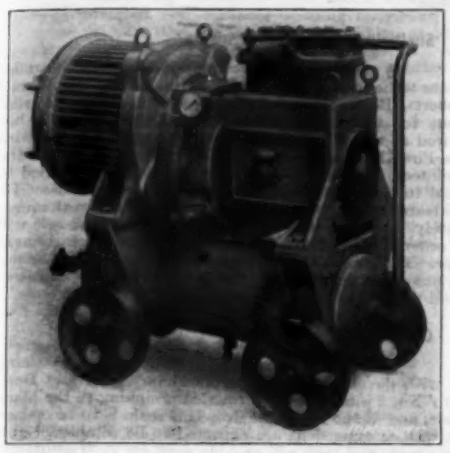


FIG. 11—REAVELL PORTABLE COMPRESSOR

the terminals of the machine. The motor runs at 1600 revolutions per minute, so that the ratio of reduction between motor and compressor shaft is as 3.2 to 1. The air receiver is at the lower part of the set, and the whole is mounted on four wheels, one pair of which is made to swivel.

A compact and efficient-looking combined stone drying and mixing plant for tar-macadam and bituminous mixtures was exhibited by Stothert and Pitt, Limited, of Bath. It is entirely self-contained and is mounted on wheels for transport, one pair being made to swivel and provided with a draw-bar. The machine is furnished with two drums, one for drying the stone and the other for mixing, the former being of the firm's Victoria type and the latter of its Smith type, both of which have long been successfully employed for mixing concrete and have already been described in our columns. The capacity of each is about 7 cubic feet, or approximately 6 cwt. of stone. The plant, so it is claimed, is capable of dealing with absolutely wet stone and of drying it perfectly in three minutes or even less. The heat is obtained from a coke furnace which is mounted low down between the axles, the drying drum being arranged vertically above it, and above the drum there is a fan—driven from the shafting which also revolves the drums—which is designed to cause a large volume of hot air from the furnace to pass through the drying drum, a means of regulating the temperature being provided. At the rear end of the machine is a loader bin, which, when lowered, is nearly at ground level, and which is brought into action by means of a Ferodo-lined cone clutch. The stone, when lifted, is discharged into the drying drum, in which it is turned over and over and brought into direct contact with the heated gases. When the batch is dried it is at once passed into the mixer drum, in which, it is claimed, that by reason of its construction, it is impossible for stones to clog or jam, and every particle of the matrix must become incorporated with the stone, since it is impossible for puddles of matrix to collect. The tar is dealt with by a small pump which is mounted on a platform beside the mixer. It is provided with a three-way cock, so that it will lift tar from ground level into a tank which is heated by the furnace gases, and which has a capacity of 40 gallons. The cock can also be set so that the pump delivers the heated tar from the tank into the mixer as required, there being a device for indicating to the attendant the exact amount of tar which is passing into the mixer. The levers for operating the discharge chute from the dryer, the tilting gear for the mixer, and the tar control are all arranged within easy reach of the operator. Three batches are handled simultaneously with this plant; one batch is assembled in the skip, while a second is drying in the drying drum, and at the same time a third charge is in the mixer. The plant exhibited had a normal capacity of from 60 to 80 tons per day. For mixing fine material and for use with bitumen, mexaphalte, and similar binders the firm has designed a special type of screw paddle mixer, which is interchangeable with the Smith tilting mixer, and an example of it was also shown upon the stand.

We are asked to state with regard to the tandem roller exhibited by Marshall, Sons and Co., Limited, and referred to in our last issue, that the engine is being made by Messrs. Marshalls, acting in association with Millars' Timber and Trading Company, Limited.

IT was thirteen years last Wednesday, the 5th inst., since the serious collision between two business trains at Willesden, one feature of which was that no less than 146 passengers were injured, besides five killed.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Improved Business Maintained.

THE improvement in the iron and steel trades in the Midlands appears to be of a substantial character, no weakness in prices having developed in any department. Trade continues to make progress, notwithstanding the Election disturbance. A good volume of new business is coming forward, and prices continue in the ascendant. Buyers, moreover, are departing from the policy they have so long pursued, and are seeking to cover their future requirements at the prices ruling to-day. It is not without significance that the coke suppliers at their recent conference with the blast-furnace owners of the Midlands fixed the price for four months ahead. A lot of business is expected to be released as a result of the settlement of labour troubles in the shipyards, and this has a stimulating effect upon the market. The general impression is that now the Election is out of the way there will be another forward movement, bringing higher prices in the New Year.

Finished Iron Prices Improving.

The improvement lately noted in the Staffordshire finished iron trade is maintained, and prices are firming up. There is still, unfortunately, a good deal of idle plant, but ironmasters are more hopeful than they have been for some time, and are anticipating improved order books to finish up the year. This week makers of good brands of iron have been able to obtain slightly higher rates for their products. The £12 basis for Crown bars is now more firmly adhered to, and some Staffordshire mills making high-grade Crown iron are able to command up to £12 10s., or 5s. more than was the case a week ago. Makers of nut and bolt bars, even in face of Belgian competition at £8 15s. delivered, are able to command most of the trade, and this week many of them have advanced their quotation to £11 per ton. This is equivalent to an advance of 5s. in the past fortnight. Bars are still obtainable, however, in some quarters at £10 17s. 6d., though this figure now appears to be the minimum. There is not much faith in the continental market at the moment, and continental shippers are reluctant to quote firm prices and conditions of delivery when inquiries are put to them. Marked bars are quite firm at £14 10s., and wrought iron gas tube strip is £12 10s. to £12 15s. Business in galvanised sheets continues brisk at recent rates.

Forge Iron Prices.

The demands made upon Midland smelters for forge brands of pig iron have been so great that this week they have seen fit to advance quotations by from 2s. 6d. to 3s. 6d. per ton. There has been a decided revival in the buying of this class of iron, and blast-furnace owners have had ample opportunity to accept forward business where they are inclined to do so. But they are not disposed to incur heavy commitments on a market basis which is considered unprofitable. Sales have been made which are very substantial when viewed in relation to the diminished output and supplies have become somewhat scarce. The price has accordingly risen, North Staffordshire forge being quoted £8 8s., Northamptonshire £4 6s., and Derbyshire £4 7s. In these circumstances furnace owners are finding it worth their while to pay increased attention to the forges. There is no corresponding impulse in the foundries, though the market shows a certain amount of improvement. North Staffordshire No. 3 foundry iron is £4 15s. upwards, Northamptonshire £4 12s. 6d. with some makers asking £4 13s. 6d., and Derbyshire is firm at £4 15s. In this area the output is considered sufficient for present requirements, and no addition to the operating furnaces is likely to be made for some time. It is recognised that smelters have been having a hard time, and though something has been done to consolidate the pig iron trade during the past two months, values have improved only very slowly. There have been misgivings as to whether the market, in view of foreign competition, would stand more than a very mild appreciation, and makers are cautious, even though anxious to recoup themselves for late reverses.

Blast-furnace Coke.

The price of blast-furnace coke has been confirmed until the end of March next on the basis of 24s. at ovens, and at present selling prices of pig iron this is considered an unprofitable figure. It had been urged for a long time past that the recovery of the iron and steel trades was being retarded by the high cost of fuel, South Staffordshire furnaces being required to pay something like double the pre-war price. At the end of September the price was reduced from 26s. to 24s. at ovens. Since then, ironmasters have pressed for further concessions, without success. The decision now arrived at, which affects the cokeries of Staffordshire, Nottinghamshire, Derbyshire, Yorkshire and Lancashire, while by no means realising what furnacemen want, is welcomed in the sense that it will make for stability by the knowledge of a definite price for a longer period than has been the case in the past.

Business in Steel.

Business in steel is quite good. The market for ship, bridge and tank plates is already feeling the favourable impulse resulting from the restoration of peace in the shipyards. Business has been done above the basis of £10, and promising inquiries are coming in with regard to forward supplies. Some little progress has been made with the Steel Plate Association, which is expected to be practically universal in its application. Care, however, is being taken not to raise prices excessively, in view of the possibilities of foreign competition. There is no further change in engineering sections, though a certain amount of underselling is arising from the speculative buying of merchants when the upward movement commenced, and it is possible to obtain joists, sections, &c., somewhat below the current prices. The steel masters are taking a strong position with regard to price, and will not allow their quotations to remain open if they are not accepted by return of post. Determined efforts are being made to establish the small bar basis at £11. The recent rise in values has been quickly followed by some buying of Belgian material. Large merchants have been able to obtain bars in considerable quantities at as low as £8 17s. 6d., or something like £2 below the price announced by the revived Bar Association. Efforts are still being made to incorporate in the Association firms which have hitherto maintained a dissentient attitude. It is not considered that these efforts will be altogether successful, although so far the new price is generally quoted. Steel strip is now quoted in many quarters at as high as £11 per ton. Staffordshire steel hoops remain at £12, though some rollers are asking an advance of 5s. per ton.

Billet Prices.

Steel billets are decidedly firmer, and more contracts, running into many thousands of tons, have been made. Last week sellers were quoting £8 7s. 6d., but the scarcity of steel scrap and its advanced price has had the effect of forcing up billet prices, so that this week few sellers are prepared to accept less than £8 15s. Some, indeed, quote £9 and upwards. Consumers are hastening to secure supplies at the prices ruling. Some foreign competition has developed, several Belgian firms, which have not been heard of for some time, having reappeared, with favourable quotations. Fairly large contracts have been arranged on the £7 12s. 6d. basis, but one large purchase is said to have been made at as low as £7 10s. High-carbon billets are unaltered on the basis of recent quotations.

Steel Scrap.

Steel scrap is a very strong market, with prices further advanced to £4 15s. Some consumers, who have allowed their stocks to become exhausted, are said to have paid £5 for quick deliveries. It is considered that the scrap price is inflated, and is quite likely to be followed by a reaction.

Ironworkers' Wages Reduced.

As a result of the bi-monthly ascertainment under the Midland Iron and Steel Wages Board, wages of ironworkers in this district are to be reduced 2½ per cent. during the ensuing two months. The new rate of wages is 55 per cent. above the basis of 13s. 6d. for puddlers. The slump in the selling prices of iron and steel during September and October is responsible for this decline in wages. The sliding scale always moves at some little distance behind the market. Since October selling prices have improved, and this will be reflected in the next ascertainment.

A Coalfield Controversy.

For some time now trouble has been expected in the Nottingham and Derbyshire coalfield over the use of forks instead of shovels in the pits. It is likely in the near future to be brought to a head, for this week a notice, signed by officials of the Notts. and Derbyshire Miners' Association, has been posted at the pitheads notifying the men to bring out forks on December 12th.

Smethwick Gas Extensions.

The Smethwick local authority, in connection with the reorganisation and extensions at the gasworks, has, I understand, entered into a provisional contract for 100 railway wagons for the conveyance of fuel, with the Birmingham Railway Carriage and Wagon Company, Limited, at a cost of £18,000. The scheme of reorganisation includes the erection of a new gasholder of 3½ million cubic feet capacity, together with boundary wall and staircase at an estimated cost of £90,850, and new trunk mains at a cost of £9666. Incidentally, it is intended to reduce the price of gas for power purposes. A 3d. flat rate reduction is proposed from September and another of a like amount from December.

Midland Workless.

For the past three months unemployment in the Midlands area has decreased week by week, and the latest returns issued by the Ministry of Labour show a fall on the week of 2918, the figure having fallen from 156,281 to 153,363. There are now 112,129 men unemployed in the area, 2631 boys, 34,505 women and 4098 girls. To the total, Birmingham contributes 38,735, Wolverhampton 7434, Cradley Heath 5079, Coventry 4311, Bilston 3423, Dudley 4710, Smethwick 4758, and Stourbridge and Brierley Hill 3652.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

THE markets for iron and metals have been firm all round, and there seems to be a growing conviction that the worst of a very difficult time is now over. It would seem that slowly things are being put into order again. One indication in this direction is a report that the German industrial magnates have come to some agreement with the French Government which will lead to the re-starting of the industries in the Ruhr district, and this would mean that the first step has been taken towards the restoration of German trade. Such a restoration would react favourably on the copper market. Another indication of improvement is that more work is said to be reaching the great engineering establishments. On the whole, the feeling is better than it was, and although nothing much can be looked for this year, there is a belief in better trade for next year.

Metals.

The copper market has been decidedly firmer of late, and there is a belief that consumers are more ready to buy for stock than they were. Just at the moment the strength of the other sections of the iron and metal markets is probably one cause for a better feeling in copper, because it is still fairly evident that the world's output of copper is more than sufficient for the present rate of consumption; but copper is one of the few staples which is at pre-war prices, and it is clear that were it not for the disparity at present existing between supply and consumption, the price would be much higher than it is. Hence, if the industrial condition of the world is really being slowly restored, copper prices may easily tend to rise until a normal relationship between the various industrial metals is again reached. Recent reports from America suggest that buying for consumption is increasing there. The position in tin is becoming more interesting, and, apparently, we must be prepared for higher prices in the near future. Of course, it must not be forgotten that since the beginning of October we have seen a rise of over 15 per cent., and a good deal of profit-taking may have to be done; but the general position of the metal is strong, simply because the consumption keeps well in excess of the monthly supplies. Were it not for the large stocks in the East, there would have been a serious shortage of tin by this time, and these stocks are being reduced every month. The consumption of tin in the tin-plate trade is steadily increasing, and seems likely to increase for some time to come. If, added to this, we have a larger demand from the engineering trades, the position, of course, will be so much the stronger. The markets for lead and spelter have been steady to firm, but spelter is still very cheap as compared with lead. The demand from the galvanisers has been good for some time, but it has now fallen off a little. Spelter prices have been comparatively steady for more than two months, and the prospects of the market seem favourable. The rumours of a very big order for zinc sheets from the Argentine have not been confirmed up to the time of writing. Galvanised sheets seem more probable. The market for lead has again been very strong, and the demand seems fully equal to the supply, if not a little in excess. The price of English lead is nearly on a level with that of spelter.

Pig Iron.

The market for foundry iron in Manchester is quite firm, not to say strong, in spite of the fact that very little new business has been done this week. The Cleveland and the Scottish iron markets are very firm, and it seems not improbable that a further advance will take place in the price of Cleveland iron. This does not affect Manchester directly, because practically no Cleveland iron is now consumed here; but it encourages Midland makers to try for rather more money. Some sellers of Derbyshire iron are now refusing to accept less than 95s. per ton on trucks, but it is still possible to buy foundry iron in Manchester at less than this would cost delivered. Nevertheless, there seems to be a good deal of confidence in the future, and even consumers of pig iron do not now seem to expect lower prices next year. One notices that some ironfounders in this district are waiting to contract for iron well over next year, but the ironmasters in Derbyshire are reluctant to sell beyond June. There is no indication that blast-furnace coke is likely to be cheaper, and at present there is no tendency in the Midlands to light up more furnaces, although it is possible that some steps in this direction may be taken next year. In calculating the chances of the pig iron market, it does not do to forget that British furnaces are still only employed to the extent of two-thirds of their capacity, and any further rise in prices would certainly bring some of the idle plant into operation.

Steel.

The steel market here is rather inactive this week, but there is no sign of any easing off in the prices. On the contrary, steel is very firm at the prices fixed by the associations. For joists and large sections, £9 10s. per ton is the price in the Manchester district, but £9 15s. is to be charged in Cheshire. Merchants have steel in hand which has cost them less than this, but they are, of course, expecting to sell at the higher prices. The demand for steel plates is said to be better, and perhaps next week, when the election is out of the way, we shall see more business passing.

Scrap.

The markets for scrap show some improvement, but the demand for foundry scrap rather lags behind. Foundries are not yet busy, and they are aware that there is plenty of cast iron scrap to be had when they are ready for it. Dealers quote 90s. and 92s. 6d. for good scrap, but are accepting orders at less. Steel scrap is very firm at 80s. per ton on trucks in Lancashire, and heavy wrought scrap at 95s. to 97s. 6d. per ton delivered to the ironworks.

BARROW-IN-FURNESS, Thursday.

Hematite.

There is no further development in the hematite pig iron trade to report. The bulk of trade is maintained, but there has been no further improvement. The steel works in the district are taking a considerable amount of iron, and the rest is being sold in home markets to a great extent. The continental trade is not brisk, neither is the business across the Atlantic. It is thought that there will be an improvement in the course of a few weeks, and perhaps when the year is turned there will be a further impetus to business. Forward delivery orders are scarce yet, and what iron is being ordered is mostly for immediate requirements. Scotland should become a better customer in the course of a few months, for shipbuilding which has been held up will improve now that the lock-out is ended. Prices are firm and likely to be, and this is, to some extent, a sign of confidence in the future.

Iron Ore.

The iron ore trade is dull, comparatively speaking, for the number of furnaces in blast in this district is not large and, consequently, none of the mines are active. Some are doing very little, and there is not much being sent out of the district. The prospects for the New Year are better. Business in foreign ore is moderate, and there is not likely to be an improvement in this branch for some time.

Steel.

Business in the steel trade continues to be better, and both the rail mills at Workington and Barrow have orders which will keep them employed for some time, Barrow particularly. At Barrow the hoop and small section mills have plenty of work. Foundries are moderately employed.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Outlook.

THE task of writing a weekly report on the condition of the Sheffield steel trade is becoming a pleasant one again, as it is possible to record a continued improvement in several of the most important branches. This is especially the case with the heavy side. An increased volume of work is reported by the makers of basic open-hearth steel in Sheffield and district, while in Lincolnshire full-time working is maintained, the bulk of the output there being absorbed by the South Wales tin-plate trade. The confidence which is felt by the large steel companies is shown by the fact that they have recently placed heavy contracts for hematite and basic pig iron, some of the supplies being sufficient to cover their requirements for three, four and even six months in the New Year. Prices of all classes of pig iron have gone up several shillings, and there has been a sharp advance in scrap prices.

Railway Material.

Although the departments making axles, tires, springs and other railway requirements are pretty busy, they are not as fully occupied as they expect to be before long. The Lord Mayor, Master Cutler and President of the Chamber of Commerce have been to London to interview the chairmen and managers of the London and North-Eastern and London, Midland and Scottish railway companies, and, as a result, are hopeful of an early placing of substantial orders in connection with the large schemes of renewal, involving the expenditure of millions which have recently been announced. The work coming forward at present is for the usual supplies, such as are periodically wanted throughout the year. The various firms are fully confident that the stream of work will be well maintained and increased. The London, Midland and Scottish Company has just given out orders for the building of 1200 wagons, which will bring work to the Sheffield shops making springs and other equipment.

Lighter Steel Trades.

The gradual improvement in crucible steel continues. This branch, which is, of course, chiefly concerned in the making of tool steel, has yet a long way to go before it recovers anything like normal activity, but it certainly appears to be progressing in the right direction. The distribution of surplus war stocks still affects the trade. They have been disposed of in bulk, but not all of them have yet reached the users. Several good foreign orders are on hand for the best local brands of high-speed steel, and the United States is a purchaser to some extent, in spite of the heavy tariff. Users are, to an increasing extent, expressing dissatisfaction with cheap tool steel, as they find it will not bear re-heating as often as the better qualities, and consequently wears out more quickly, and there is a growing demand for the superior kinds, irrespective of price. Continued upward progress is noticeable in files, saws, edge tools, hack saws and hammers. In several instances, quite good time is being worked at the factories. Australia and New Zealand are good customers for these classes of material. Australia is developing her own iron and steel industry, but this increases her need of many of the finished and specialised products of Sheffield.

German Cutlery Imports.

Serious damage is being done to the Sheffield cutlery trade by cheap German imports. These imports, during 1922, were as under:—Knives, other than machine knives, including knife blades and blanks, 621,356 dozens, valued at £106,642; scissors and shears, including blanks, 434,709 dozens, valued at £94,931; safety razors, 1,022,990 dozens, valued at £36,671; other razors, 152,638 dozens, valued at £47,726; other cutlers' wares, entered by value only, £24,599. The differences between these prices and Sheffield prices are striking. For instance, the value of the knives imported works out at an average of 3s. 5d. per dozen, whereas the cheapest pocket knife made in Sheffield to-day costs 6s. 7d. per dozen for labour only. The average price of the imported scissors and shears is 4s. 4d. per dozen, while a common quality 3½in. embroidery scissors costs to-day in this country in wages alone, 7s. 9d. per dozen. With regard to ordinary razors, the average price of the imported goods is 6s. 3d. per dozen. A common quality razor made in this country to-day costs in wages alone 15s. 2d. per dozen. The total loss of wages to British cutlery makers during 1922, owing to this cheap German competition, is stated to have been, on the most conservative estimate, £488,728.

Condition of Cutlery and Plate.

The seasonal orders for the better classes of these goods are tapering off, and it is probable that they will all be executed before Christmas. New orders, however, continue to arrive for cheap goods, for which there is a large demand. The custom of giving presents of cutlery and plate to purchasers of soap and other much-advertised specialities is extending, and big orders are being executed on this account. The business is so keenly competed for, however, that it produces little profit. There is a large sale for spoons and forks, both at home and abroad. Small cases to hold half a dozen spoons, tea knives and similar articles are now being supplied as cheaply as they were before the war, and the makers of low-priced plate are doing a very good business in them. Sheffield is doing an increasing business in safety razor blades, which appear to be giving satisfaction to those who have hitherto been accustomed to the best American makes.

Sheffield and the New Cruisers.

A good item of news of interest to the steel trades comes to hand while I am writing this letter. Sir Samuel Roberts, Bart., for twenty-one years Member of Parliament for the Ecclesall Division of Sheffield, who has retired at this election, has been in communication with the First Lord of the Admiralty on the subject of the seventeen cruisers which the Government has decided to build to take the place of the old "County" class. He has learnt that it is proposed to go on with the work immediately, and that it is hoped that ten of the vessels will be ordered either before the end of this year or early next year. The First Lord has assured Sir Samuel that he has given special instructions that Sheffield shall be borne in mind when the orders are given out.

Colliery Progress.

The Staveley Coal and Iron Company is pushing on with developments at its Markham No. 1 and Barlboro' No. 2 pits. At the former, it is sinking to the black shale, and at the latter the deep soft seam is to be opened up. These extensions are expected to be completed in a few weeks, and they will provide work for 2000 additional men. At Markham No. 2, another of the company's pits, the haulage system has just been rearranged, and this will not only facilitate the haulage of coal, but will improve the conditions under which the men work. At this colliery 300 more miners are urgently needed. A big colliery deal has been reported during the week. Messrs. S. Instone and Co., the proprietors of Askern Main, in the Doncaster district, have acquired the Hoyland Silkstone Coal Company's pits and by-products plants, including the Hoyland Silkstone, Hoyland New Silkstone, Hoyland Parkgate and Haigh Moor pits. They are also negotiating for the acquisition of a controlling interest in the Llanbradach pits, South Wales.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Steady Trade Revival.

THE month of November witnessed the beginning of a most encouraging revival in the iron and steel industry in the North of England. To the benefit of buyers prices remained practically stationary, and there was a steady expansion of demand, both on home and foreign account, with the result that additional furnaces were put into blast. There are now forty-four blast-furnaces operating on the North-East Coast, compared with only thirty-nine at the beginning of November. A steadily progressive improvement is to be recorded in the export trade, and for the second month in succession the shipments of iron and steel from the Cleveland district exceeded 100,000 tons. The figures for the past three months have been: September, 98,670 tons; October, 106,362 tons; and November, 110,369 tons. Owing to the fall in the coastwise shipments, the pig iron trade by sea shows a slight reduction, but the foreign shipments show practically no variation in the aggregate, being 27,424 tons in November, compared with 27,737 tons in October. Smaller quantities were shipped to Germany and to Denmark, but the improved volume of trade with Belgium and France was maintained, and there was a big expansion of trade with Italy, in addition to which 2650 tons were shipped to the United States. The total exports of pig iron reached 38,369 tons. The real advance was made in the exports of manufactured iron and steel, the November total of 72,000 being the best recorded for any month for over ten years past, and over 7500 tons more than in October. To India and Ceylon alone nearly 30,000 tons were shipped, and nearly 10,000 tons to Australia and New Zealand, while Japan took a larger quantity.

Iron and Steel Imports.

The imports of pig iron from European countries and coastwise to the Tees during the months of October and November, totalled 2556 tons, as compared with 350 tons a year ago, and 268 tons for the corresponding pre-war period of 1913. Plates, bars, angles, rails and sheets imported during the last two months totalled 1215 tons, as against 1349 tons a year ago, and 3601 tons in the same months of 1913. The imports of crude sheets, bars, billets, blooms and slabs, amounted to 13,503 tons, as against 10,488 tons a year ago, and 10,986 tons in 1913.

Cleveland Iron Trade.

There are no new features of moment in the Cleveland pig iron trade. If anything, business has been a shade quieter this week owing to the election and the near approach of the turn of the year. During the stock-taking period, which is now at hand, it is not usual for consumers to carry large stocks, and, consequently, there is rather less pressure to buy than was the case a week ago. Still, makers are in a good position. They have healthy order books, and have not really a great deal of prompt iron to sell. Thus, they can afford to rest on their oars. Prices are firmly maintained, No. 1 being 107s. 6d.; No. 3 G.M.B., 100s.; No. 4 foundry, 98s., and No. 4 forge, 97s.

Hematite Pig Iron.

The demand for East Coast hematite pig iron

is particularly strong, and with only twelve blast-furnaces in the district producing this class of iron, there is no surplus whatever. Prices, consequently, tend to stiffen, and although prompt iron can be bought at 101s. 6d. for mixed numbers, makers are asking 102s. 6d. and upwards for next year's delivery, and the premium for No. 1 is quite firm at 1s.

Ironmaking Materials.

Some big contracts have been arranged for foreign ore, but new business is being restricted by increased prices. Best Rubio ore is now quoted at 24s. 6d. c.i.f. Tees. Coke is rather firmer. There is a strong export demand, and with more furnaces in blast ironworks are needing more. Good medium furnace kinds are about 39s. per ton delivered at the works.

Manufactured Iron and Steel.

The resumption of operations in the shipyards has had a most beneficial effect upon the manufactured iron and steel trade. Specifications are now coming forward freely from shipbuilders, and more rolling plant is being put into operation. Other sections of the steel trade are also receiving more orders, and the outlook in the industry is considerably brighter. With very little foreign semi-steel now on offer, billets show a hardening tendency. A week or two ago soft billets could be bought at £8 17s. 6d. per ton, but £9 is now a pretty firm price. Finished steel prices are unchanged, but very firm.

The Coal Trade.

The Northern coal trade has assumed a little quieter tone during the past few days, which is more or less to be accounted for by the bad weather, including fogs on the East Coast and in the Channel. This has delayed steamers, dislocated tonnage, and has hampered the working of the collieries to a little extent. As a consequence, there have been supplies of coal available for immediate disposal. But, though holders and producers have been naturally anxious to clear them quickly, there has not, as yet, been any appreciable relaxing of the stringency, or much, if indeed any, material alteration in prices. The inquiry from abroad is fairly extensive, but actual bookings are limited. In the Mediterranean area and France, the United States' competition is very keen, and heavy bookings from America to Italy and France have recently been reported, and there are others in prospect. As long as present high figures are quoted on this side, the American coals can be competitive in those countries, though, so far, they have been less successful in Belgium and Scandinavia. The collieries, however, are very well sold for some little time onward, and as there are encouraging signs of greater activity in the home trade, they are unwilling to discuss business except on the terms of present quotations. Best screened Northumberland steam coals are firm at 26s. per ton direct, while in second hands the quotation is very little, if at all, less. Second steams are steady and in good request, while small steams of all makes are easily disposable at quoted prices. The Durham market is steady for all classes of gas coals, prompt, or early forward. The coke market is quieter, and prices can be discounted occasionally.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE outlook in the shipbuilding industry has naturally improved greatly with the settlement of the boilermakers' dispute. Some yards have a fair number of vessels on the stocks, and in others work is being resumed on the completion of vessels which were held back by the strike. A number of new orders have been announced, chiefly for cargo vessels, the majority of which will be commenced at an early date. Other vessels have been held up for many months, owing to costs of production, and some of these may be proceeded with. Some new work has already been started, but until the specifications are fully prepared and through the drawing-offices, employment cannot be largely added to immediately, but only gradually increased. Consequently, a few weeks must elapse before anything approaching normal conditions are established. The amount of work completed during November was exceedingly small, the total tonnage launched from Clyde yards only amounting to eight vessels of 5034 tons aggregate, less than half the aggregate for the month of October and less than one-tenth of the amount for November, 1922. The aggregate tonnage for this year to date amounts to 99 vessels of 172,275 tons aggregate, against 114 vessels of 369,326 tons aggregate in the same period last year. The only vessel of note launched during November was the Kathiawa, s.s. motor ship, 4320 tons, built and engined by Harland and Wolff, Limited, Glasgow, for the Bank Line, Limited (Andrew Weir and Co.), London. Harland and Wolff have a number of similar vessels on hand for the same owners, which will provide work at their Govan yard for about two years. Alex. Stephen and Sons, Linthouse, have a contract for a large passenger vessel for the P. and O. Steam Navigation Company, and the Fairfield Company is to resume work on the Anchor-Donaldson liner Letitia, on which vessel work has been suspended for about two and a-half years. Reconstruction and repair work of a considerable amount will also be carried out in yards on the upper reaches of the Clyde. The industry in this area also is anticipating its share of the light cruiser contracts. Busy times are in prospect for the industry in Port-Glasgow and Greenock also, more particularly the latter.

Growing Demands for Pig Iron.

The recent improvement in the demand for pig iron is maintained. Consumers are covering future requirements as far as possible, and home inquiries are increasing. A continuance of present conditions will necessitate the putting into blast of additional furnaces. In the meantime, producers are apparently not too eager to sell at the prices obtainable, and it is probable that another advance will be announced very soon. Offerings of continental foundry and basic iron are reported, but only small sales have been mentioned.

Bar Iron.

The bar iron works are becoming busier. More orders are coming forward on home account, and some of the firms have enough tonnage on hand to last several weeks. No advance in home prices has been intimated yet, but a firmer tendency is apparent. The re-rolled steel branch of this industry is busier on both home and export account.

Steel.

The steel works generally are already a little better employed in the plate and sections departments, and also on rails, but there is, of course, still plenty of room for improvement. Consequently, the sheet trade continues to provide the bright spot. Thin sheets have a good export turnover, and makers report heavier bookings in thick sheets for home delivery. Galvanised sheets, too, are busy.

Scarcity of Scrap.

An increasing demand is being experienced for heavy smelting and wrought iron scrap. Forward inquiries are more prolific, but holders are not offering a large tonnage for future delivery. Supplies are scarce all round.

Coal Remains Firm.

Although there is little fresh business in export coal comparatively speaking, outputs are still almost fully taken up by old contracts. Home demands have improved for both round and small coals, and this has kept up the prices of export fuel, which have firmed up again. Shipments from West of Scotland and Lothians ports are prompt, but a turn of one week to ten days is the rule at the Fifeshire ports, where a good supply of steamers has arrived. Aggregate shipments amounted to 287,958 tons, against 305,298 tons in the preceding week and 268,536 tons in the same week last year. Foreign shipments were lower, but coastwise traffic was comparatively heavy. In the home market, steady prices are reported for washed nuts and dross, while the tendency of round fuels is upward.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THERE has been a marked improvement in the general state of the steam coal trade during the past week. Prices of practically all grades of coal, excepting perhaps dry qualities, have advanced, though the probability is that the latter descriptions will share in the better conditions before very long. The pressure all round is very heavy, owing to the fact that shippers only have a bare three weeks in which to execute their commitments for this month, as the last week of this month will, to all intents and purposes, be a holiday period. Merchants generally have speeded up their arrangements, and there has been a good deal of buying, with the result that collieries, in view of their curtailed production for this month, are virtually full up, and for any odd parcels which they may be able to stem they are asking enhanced prices. There is every prospect of the present firm conditions extending well into January; indeed, exporters are already arranging to postpone some of the coals which they required this month for shipment during January, which arrangement will suit the collieries equally well, as some of the leading undertakings have now more on their stem than they can cope with comfortably. Unfortunately, steamers are not being turned round at South Wales ports with the expedition that is desired, and this, of course, throws back the tonnage which is due to come along. This week there have been as many as forty steamers waiting loading berths, and unless something is done to deal with tonnage more rapidly, it is certain that many steamers which under ordinary circumstances should be loaded and sailed before Christmas will be detained until after the holidays, which is a serious matter, seeing that it means the loss of a week practically. The demand from abroad is a shade better, and it is understood that the Spanish railways have purchased about 22,000 tons of Monmouthshire and second Admiralty large coals for shipment this month. It is also reported that the State Railways of France have bought considerable quantities of large and small coals for delivery over the first three months of next year, while the Algerian State Railways are in the market for 85,000 tons of patent fuel for shipment during the first six months of 1924.

Third Shift Stopped.

Something in the nature of a bombshell fell upon coalowners and exporters on Monday last when it became known that as the result of a meeting held over the week-end the tippers had decided to stop working the third shift. Unfortunately, this decision has been acted upon, and this week there is no work on the night shift. The trimmers had received a communication from their headquarters that they were to carry on with the third shift temporarily until some definite arrangement between the workmen's representatives and the employers was come to; but, of course, with the tippers adopting the arbitrary course decided upon by them, the trimmers could do nothing. It is very unfortunate that proper arrangements could not have been made between the parties before the experimental period came to an end last week to have the whole question discussed and an agreement framed. The result is that a last-minute decision of the workmen to refrain from working the night shift has thrown things into confusion. Their action caused consternation among exporters who had chartered tonnage with short loading hours, and are now confronted with the prospect of having heavy demurrage bills to pay. As a matter of fact, the detention of tonnage is already serious, as over forty steamers were reported this week to be waiting loading berths, and in many cases steamers are on demurrage before they even get into berths. The position was regarded as so important, not only to coal exporters, but to colliery owners and shipowners, that a hurriedly called meeting was held at the Cardiff Coal Exchange on Monday, and the following day there was a meeting of the special committee of the General Committee, comprising representatives of the Coalowners' Association, Shipowners' Association, exporters and Chambers of Commerce to consider the situation. Drastic action was threatened on the part of the employing interests, and the position as it now stands is that a communication has been sent by the headquarters of the N.U.R. to the tippers requesting them to carry on with the third shift until a joint conference has been held. This joint conference is to be held on Friday of this week, but the local tippers show no disposition to carry out the request of their headquarters, and all that they have done is to arrange for mass meetings of the men to be held on Sunday next to consider the whole matter.

The Tin-plate Industry.

The notices which were served by the enginemen and firemen engaged at the tin-plate works in this district, and which were due to expire at the end of last week, were withdrawn at the last moment, except in the case of two works at which about 500 to 600 men were engaged, and the result was that these two works were idle on Monday last, but on Tuesday work was resumed. The men believed that one of their number had been victimised by the employers, and they therefore refused to withdraw their notices. However, as the result of an inquiry, it was shown that the men were not justified in taking the view they had, and consequently they decided to return to work. There is, however, trouble with the fitters, smiths and other craftsmen in the tin-plate works at Neath and Briton Ferry. Representatives of the various unions connected with the works met on Monday last, but no settlement was arrived at, and consequently these workmen are on strike. They demand an increase in wages, and that they should not be subject to the award of the South Wales Engineers' and Ironfounders' Joint Wages Board. They contend that under that award they have failed to secure any redress or recognition of their demands, and that with an improvement in the tin-plate trade they are entitled to better wages.

Colliery Acquisitions.

The official announcement is made that S. Instone and Co., Limited, of London and Cardiff, have arranged to acquire the well-known Yorkshire undertaking of the Hoyland Silkstone Coal and Coke Company, Limited, which employs about 2000 workmen and has an output of about half a million tons of coal, &c., per annum. It was also reported that negotiations were in progress for the acquisition of the Llanbradach Collieries in South Wales, belonging to the Cardiff Collieries, Limited, but since then it is stated that these negotiations were of the flimiest character possible, and are not therefore likely to mature. With regard to the recent offer by the directors of Guest, Keen and Nettlefolds, Limited, to the ordinary shareholders in D. Davis and Sons, Limited, it is now announced that in view of the large number of acceptances the deal is to be completed.

Mining Engineering Exhibition.

Keen interest has been manifested in the Mining Engineering Exhibition, which opened at the Drill Hall at Cardiff on Thursday last week, and remains open until Saturday. The Exhibition is under the auspices of the South Wales Institute of Engineers, which, encouraged by the success of its first venture in 1921, which was confined to fuel-saving appliances, and of the general exhibition which was held last year, decided to have an exhibition of machinery and appliances applicable to the South Wales coal-mining industry. Limited to this extent, the accommodation was not equal to the requirements, when it is considered that about seventy manufacturing firms from all parts of the country were represented. The South Wales Institute of Engineers has made it clear that this organisation is in no sense a trading concern, its object in arranging the Exhibition being solely to bring together at a convenient centre the very latest in scientific apparatus and mechanical appliance in order that colliery owners, engineers, officials, students and others might be brought into touch with the latest developments. Incidentally, of course, a good business is looked for on the part of the firms which are displaying their goods. The Exhibition, which was opened by the Lord Mayor of Cardiff (Alderman Sydney Jenkins), has been well attended, and on Saturday last the members of the South Wales Colliery Association paid an official visit to it. The President of the Institute (Mr. W. Johnson), the officers and secretary (Mr. Martin Price), have every reason to be satisfied with the success of the undertaking. Synchronising with the Exhibition there have been meetings of the Institute, at which highly important and interesting papers have been read, not the least important being a lecture on the mining industry by Mr. Evan Williams, the chairman of the Mining Federation of Great Britain, which was delivered on Tuesday.

Current Business.

Business has been fairly active in steam coals, but it is unlikely that operations from now on will be active, for the reason that coals for shipment this month are practically unobtainable. Collieries are fully sold, and the market is very firm. Best Admiralty large are now quoted at 29s. 6d. to 30s., and second qualities range from 28s. to 28s. 6d. Small coals have strengthened considerably since a week ago. Coking qualities are strong, and some collieries are asking as much as 25s., while superior steam smalls easily command 22s. The scarcity of small coals is most pronounced, while coke is so heavily booked up that the price has advanced to 55s. or 60s. In the case of anthracite coals, the market displays practically no alteration, though most collieries are fairly comfortably off for orders.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 5 0	—
No. 1 Foundry	5 8 9	—
No 3 Foundry	5 3 9	—
N.E. COAST—		
Hematite Mixed Nos.	5 1 6	5 1 6
No. 1	5 2 6	5 2 6
Cleveland—		
No. 1	5 7 6	5 7 6
Silicious Iron	5 7 6	5 7 6
No. 3 G.M.B.	5 0 0	5 0 0
No. 4 Foundry	4 18 6	4 18 6
No. 4 Forge	4 17 6	4 17 6
Mottled	—	—
White	—	—
MIDLANDS—		
(2) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 8 0	—
„ „ Foundry	4 15 0 to 5 0 0	
(2) Northampton—		
Foundry No. 3	4 12 6 to 4 13 6	
„ Forge	4 6 0	—
(2) Derbyshire—		
No. 3 Foundry	4 13 6 to 4 15 0	
Forge	4 7 6 to 4 10 0	
(2) Lincolnshire—		
No. 3 Foundry	4 17 6	—
No. 4 Forge	4 14 0	—
Basic	4 15 6	—
(4) N.W. COAST—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 15 0 (a) / 6 0 0 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best „	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 0 0 to 12 10 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 17 6 to 11 0 0	
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates, ½in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 15 0	—
Angles	9 10 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 0 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 5 0†	—
Light „	9 10 0 to 10 0 0†	
Billets	8 10 0 to 11 10 0†	
Hoops	14 10 0	—
MANCHESTER—		
Bars (Round)	10 10 0 to 10 15 0	
„ (others)	10 5 0 to 10 7 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	10 5 0 to 10 10 0	
„ (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	9 0 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 10 0	—
MIDLANDS—		
Small Rolled Bars	10 10 0 to 11 0 0	
Billets and Sheet-bars	8 7 6 to 8 15 0	
Gas Tube Strip	10 15 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	19 0 0 to 19 5 0	
Angles	9 15 0	—
Joists	9 15 0	—
Tees	10 15 0	—
Bridge and Tank Plates	10 0 0 to 10 5 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/9 to 24/3
Block Tin (cash)	236 15 0
„ (three months)	237 12 6
Copper (cash)	62 5 0
„ (three months)	63 2 6
Spanish Lead (cash)	31 10 0
„ (three months)	30 0 0
Spelter (cash)	32 17 6
„ (three months)	33 2 6
MANCHESTER—	
Copper, Best Selected Ingots	66 10 0
„ Electrolytic	68 0 0
„ Strong Sheets	95 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 3½
Lead, English	33 0 0
„ Foreign	31 0 0

FERRO ALLOYS.

(*All prices now nominal.*)

Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
	Per Ton.	Per Unit
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£22 0 0	8/-
„ 8 p.c. to 10 p.c. „	£21 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£50 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£65 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 6/- per unit	
„ Vanadium	20/- per lb.	
„ Molybdenum	9/- per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£130	
Cobalt	11/6 per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	23/-
„ „ Ell	24/-
„ „ Splint	24/9 to 27/6
„ „ Trebles	23/6
„ „ Doubles	22/6
„ „ Singles	19/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	23/-
„ „ Splint	24/6
„ „ Trebles	23/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	22/9 to 24/6
Screened Navigation	28/-
Trebles	24/- to 25/-
Doubles	22/6
Singles	20/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	24/3
Secondary Steam	22/3
Trebles	23/6
Doubles	23/-
Singles	20/-

ENGLAND.

(8) N.W. COAST—	
Steams	29/-
Household	46/8 to 57/6
Coke	43/6
NORTHUMBERLAND—	
Best Steams	25/- to 26/6
Second Steams	22/6 to 23/6
Steam Smalls	14/6 to 16/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/-
Second	22/6 to 23/6
Household	25/- to 28/-
Foundry Coke	50/-
SHEFFIELD	Inland.
Best Hand-picked Branch	31/6 to 32/6 —
Barnsley Best Silkstone	27/6 to 29/- —
Derbyshire Best Brights	27/- to 29/- —
„ „ House	23/- to 24/- —
„ „ Large Nuts	21/- to 22/6 —
„ „ Small „	15/- to 16/- —
Yorkshire Hards	21/- to 23/- —
Derbyshire „	20/- to 22/- —
Rough Slacks	12/6 to 13/6 —
Nutty „	10/- to 12/- —
Smalls	5/- to 8/- —
Blast-furnace Coke (Inland)	26/6 to 27/6
„ „ (Export)	f.o.b. 31/- to 31/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	29/6 to 30/-
Second „ „	28/- to 29/
Best Dry Large	27/- to 28/-
Ordinary Dry Large	26/- to 27/-
Best Black Vein Large	27/- to 28/-
Western Valley „	26/- to 27/-
Best Eastern Valley Large	25/- to 26/-
Ordinary „ „	24/- to 25/-
Best Steam Smalls	20/- to 22/-
Ordinary „	18/- to 20/-
Washed Nuts	27/6 to 30/-
No. 3 Rhondda Large	29/- to 30/-
„ „ Smalls	24/6 to 25/6
No. 2 „ Large	24/- to 25/-
„ „ Through	19/- to 20/-
„ „ Smalls	16/6 to 17/6
Coke (export)	52/6 to 60/-
Patent Fuel	30/- to 32/6
Pitwood (ex ship)	32/6 to 33/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	40/- to 45/-
Seconds	34/- to 36/-
Red Vein	32/- to 33/-
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 53
Beans	42/6 to 45/-
Peas	26/- to 27/-
Breaker Duff	12/9 to 13/-
Rubbly Culm	13/- to 14/-
Steam Coals:	
Large	24/- to 25/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at over and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(*From our Correspondent in Paris.*)

A Trade Compromise.

WHILE the undertaking which has been given by the German magnates in the Ruhr to resume work and continue deliveries for reparation is regarded as a great victory, it is nevertheless now seen that the end of the resistance is really only one step towards a general settlement of the many complicated trade problems in Europe. The Protectionist propaganda in Great Britain has shown the French that something must be done to counteract a policy that may have serious consequences for this country. It is obviously impossible for France to put forward concrete proposals until it is known what the future British policy is likely to be, and therefore vague suggestions are being thrown out for an arrangement under which a political understanding will be accompanied by commercial concessions on both sides. In the present state of affairs, when the exchange rate almost entirely precludes any chance of doing competitive business on the Continent, it is difficult to see the form such concessions could take to be of any advantage to Great Britain; but it is evident that if the situation generally should be so far settled as to permit of a stabilisation of European exchange it would be possible to suggest a compromise beneficial to both countries. So far the efforts to carry out a programme of short-term commercial arrangements have not been uniformly successful. With Poland and Czecho-Slovakia they have given good results because they have enabled French capitalists to secure a hold on those markets; but Spain is dissatisfied, and Belgium is now complaining that the commercial treaty entered into with France several months ago has given negative results. The fear of the British market being lost to Belgian goods is giving rise to a movement in Belgium in favour of Free Trade with France. Such a policy would only be possible under stress of political necessities, but the suggestion of Free Trade between the two countries is significant of what may possibly happen when the different European countries find that they are being stifled by insuperable fiscal barriers.

The Alma Bridge.

The Alma Bridge in Paris is noteworthy as offering a popular means of determining the level of the Seine, for when the feet of the massive zouaves, which adorn the piers, are in the water it is known that a period of flood has set in. The bridge, however, bears a more unfavourable reputation amongst the engineers of the Ponts et Chaussées, who regard it as one of the chief impediments to river traffic when the water level is high. It is the lowest of the Paris bridges, and this is due to a sagging of the central span soon after it was built in 1856, when it subsided no less than 52 cm. For a long while it has been proposed to reconstruct the central arch so as to bring it to the same level as the other bridges, but the Conseil Supérieur des Ponts et Chaussées has now come to the conclusion that it is better to reconstruct the three arches, increasing the height of the central one by 1.39 m. The pressure of water on the piers is to be relieved by the construction of a buttress in the form of a breakwater. One reason for recommending this work is the deepening of the Seine, which is to be carried out in connection with the Paris seaport scheme. This will give a higher velocity to the current, and, while diminishing the risks of flood, will put a greater pressure on the bridge piers.

Paris Traffic.

The traffic in Paris has increased so rapidly during the past four years that it is reaching a point at which it threatens to become unmanageable. Along the main boulevards there can be no hope of relief from the congestion except by a reduction of the surface traffic, and it was hoped that a solution would be found in the construction of underground moving platforms, of which some are being experimented with on a small scale. While it is quite possible that endless platforms will be eventually constructed in Paris, they will not solve the problem of vehicular traffic, and it was recently proposed to build an underground motor road the whole length of the boulevards. The scheme, however, has been abandoned in favour of a Metropolitan line, with subways for foot passengers from one side of the boulevard to the other. As it is quite impossible to carry out surface works on a large scale in this populous thoroughfare, it is proposed to sink concrete piles to a sufficient depth every 5 m. and to lay the roadway on them. On this work being completed the two tunnels would be driven for the Metropolitan Railway without inconvenience. The scheme is now under consideration and will doubtless undergo considerable changes before it assumes a definite shape, while the final realisation may be relegated to the distant future.

Helicopters.

After working on his helicopter for two years or more M. Pescara has succeeded in keeping in the air for nearly six minutes and travelling backwards and forwards in two straight lines with a turn, which is said to be the best officially recorded performance for this type of machine. It is believed that the previous failures of the Pescara helicopter, as well as probably of others, were due largely to want of experience in handling the machine. The control of the helicopter needs a special training, for which opportunities are at present lacking.

Trade Profits.

Notwithstanding the steadily increasing wages and higher charges, some of the big engineering concerns are able to show large profits on the past year's working. Those who supply steam turbines, steam generators, sugar making and other machinery for reconstruction have been doing very well indeed, and there have been recently important inquiries for South American and other markets. There is no doubt that the further depreciation of the franc has brought in a fair volume of foreign business. On the other hand, firms which specialise in general constructive engineering work are not so well off, and in many cases their balance sheets have shown losses.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

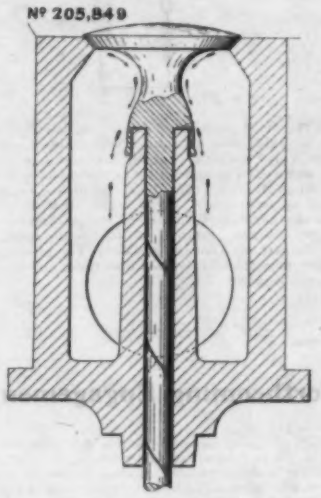
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

205,849. June 26th, 1922.—MUSHROOM VALVES, T. A. Lawrie, Edithburg, South Australia, and F. G. Gifford, 9, Thomas-street, Croydon, South Australia.

The inventors aim at facilitating the passage of the exhaust gases, after they have passed the exhaust valve, and the cooling of the valve stem. The upper part of the valve stem is enlarged,

Nº 205,849



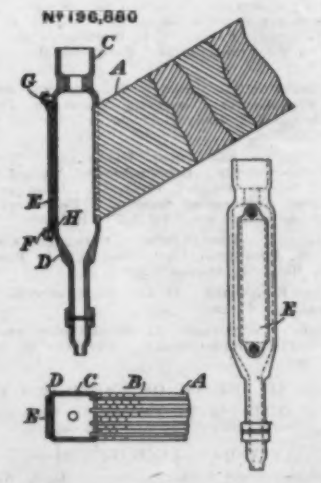
as shown in the drawing, and so shaped that it provides a streamline surface for the gases to flow over towards the exhaust outlet, while the valve guide is extended and recessed into this enlarged part of the valve. A spiral groove is cut round the valve stem with the idea that a current of air will be drawn up it and help to keep the stem cool.—*October 26th*, 1923.

LOCOMOTIVES.

196,880. July 28th, 1922.—IMPROVEMENTS IN COLLECTING PIPES FOR COOLING ELEMENTS, Aktiebolaget Ljungströms Angturbin, of Arsenalsgatan 2, Stockholm, Sweden.

In locomotives provided with air-cooled condensers it has previously been proposed to produce the elements of the condenser of flattened pipes, provided, if desired, with ribs, and to combine the elements in groups with a common collecting pipe. In such cases it has proved difficult to secure the elements to the collecting pipes in a reliable manner. This invention relates to an improvement in these collecting pipes and the object is to facilitate the soldering of the cooling elements to the pipes and

Nº 196,880



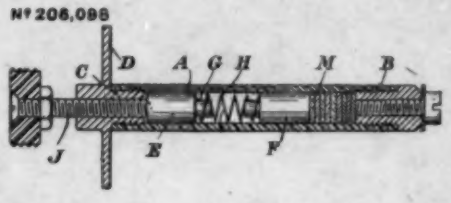
to render it possible to clean the inside of the cooling elements and to inspect the pipes. The cooling elements A provided with projecting ribs B are fixed to a collecting pipe C. At the part D which is remote from and opposite to the group of cooling elements A the collecting pipe C is provided with an opening closed by a cover E. This cover is fixed to the pipe by means of bolts F and G, a tight joint between the cover and the walls of the collecting pipe being made by means of packing H. The cover E is removable and the interior of the cooling element is directly accessible for cleaning with the aid of any scraper or by blowing in compressed air or steam.—*October 25th*, 1923.

TELEGRAPHS AND TELEPHONES.

206,098. June 11th, 1923.—IMPROVEMENTS RELATING TO HIGH RESISTANCES FOR GRID LEAKS AS USED IN WIRELESS TELEGRAPHY AND TELEPHONY APPARATUS AND THE LIKE, A. E. Watkins, 134, Olive-road, Cricklewood, London, N.W. 2.

This invention relates to improvements in high resistances such as are used for grid leaks in wireless telegraph and telephone installations. The object of the invention is to provide a high resistance which can be varied over a wide range. In the drawing A is a tube of insulating material which is closed at the rear end by a brass terminal plug B and at the front end by a brass terminal plug C, which is made in one with a plate or disc D. The disc D is for fixing the unit and it also acts as one of the terminals. Within the tube there are two plungers E F with a compression spring G between them, the spring being centred

Nº 206,098



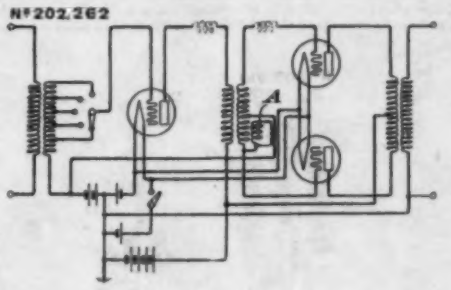
by engaging with central projections H on the adjacent ends of the plungers. Through the plug C is screwed a screw J on which an insulation knob or handle is secured. Between the plunger F and the plug B there is a number of resistance pellets M, the number of these pellets varying with the electrical resistance required and the nature of the material from which the pellets are made. By screwing the screw J outwards the effective resistance of the device is increased.—*November 1st*, 1923.

MEASURING AND TESTING INSTRUMENTS.

202,262. December 1st, 1922.—IMPROVEMENTS IN ELECTRIC TRANSFORMERS AND CIRCUITS THEREFOR, *The Western Electric Company, Limited, of Norfolk House, Victoria Embankment, Westminster.*

In amplifiers for speech frequencies, transformers have heretofore been used, having either an actual inductance or leakage inductance resonating with the valve capacity at a frequency in the upper part of the audible range. This produces an increase in gain at the upper frequencies which would otherwise be attenuated by the shunt capacity. In certain cases where filters are not employed it has been found that the gain at the resonance

Nº 202,262

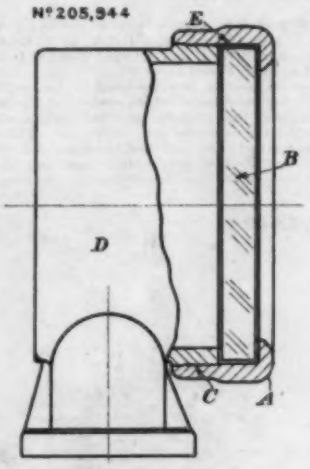


frequency may be sufficient to cause the circuit to sing. The object of this invention is to reduce the gain in circuits of this kind at and near the resonant frequency, without substantially reducing the gain at lower frequencies. The object is attained by placing on the transformer a small third winding A having its terminals connected by a low resistance path, or short-circuited, the resistance of the third winding being so proportioned to the voltage developed across the third winding that it is the equivalent of a large resistance connected in shunt to one of the main windings. This damps the resonance mentioned, and is found to be much more economical than the insertion of a large resistance in shunt to the winding.—*November 1st*, 1923.

205,944. August 25th, 1922.—IMPROVEMENTS IN ELECTRICAL INSTRUMENT CASES, Crompton and Co., Limited, and William George Smith, of Arc Works, Chelmsford.

According to this invention, the front of the instrument case consists of a screwed metal ring in which is fitted a circular slab of plate glass. The glass slab is composed of polished plate glass at least ¼in. thick, and is cemented to the inner side of the ring,

Nº 205,944



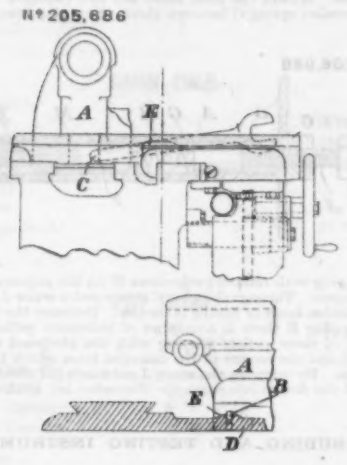
so that when the ring is screwed home the glass fits down tightly on a piece of packing placed on the top edge of the case, thus forming a flame-proof joint. In the drawing A is the ring, B the plate glass, C the screw thread which holds the ring on the case D, and E is packing material. The instrument is intended for use in explosive mines and other places where inflammable gases are present.—*November 1st*, 1923.

MACHINE SHOP AND TOOLS APPLIANCES.

205,686. October 21st, 1922.—IMPROVEMENTS APPERTAINING TO LATHES, Arthur Smith, of Dean, Smith and Grace, Limited, of Worth Valley Works, Keighley.

In lathes, particularly of comparatively large dimensions having heavy movable headstocks and saddles, it is often

desirable to be able to move the loose headstock along with the saddle when operating the saddle through its rack or other operating mechanism. According to this invention the loose headstock A has an appropriate rectangular opening B. The

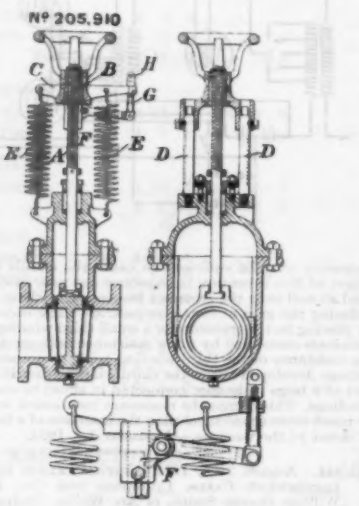


opening receives a bar, such as the end C of a wrench or spanner, which reaches across the extending portion of the saddle D to engage a slot or groove E which is formed by thickening or forming a raised part E.—*October 25th*, 1923.

TRANSMISSION OF POWER.

205,910. July 29th, 1922.—QUICK-CLOSING VALVES, Sir W. G. Armstrong, Whitworth and Co., Limited, and G. Scott, Elswick Works, Newcastle-on-Tyne.

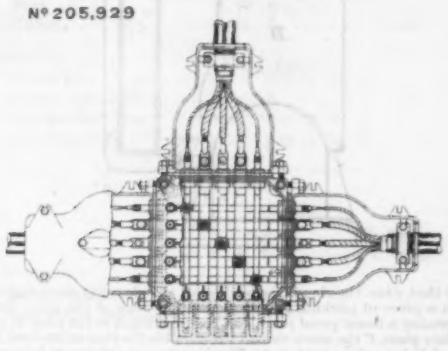
The stem A of this valve is threaded for the nut B fixed to the hand wheel with which it is opened, the nut bearing meanwhile against the crosshead C. The crosshead is held in position on the



pillars D D against the tension of the springs E E by catches F, which are pressed into recesses in the pillars by the spring G. If the catches are released by pulling on H the springs immediately close the valve. The lower view shows the catches more plainly.—*October 29th*, 1923.

205,929. August 9th, 1922.—IMPROVEMENTS IN ELECTRICAL JOINT BOXES, Charles John Baker, of 7, Karteret-street, Westminster, S.W. 1, and Edward Rendell Ingram, of 19, Hampton-road, Forest Gate.

The improved junction box described in this specification has a central bus-bar chamber in which are sets of bus-bars crossing one another, and this chamber is filled with insulating compound to cover the bus-bars and connectors. The ends of the bus-bars are formed as, or attached to, means for connection to conductors, described as connecting tags, and these project through the sides of the chamber as shown. Connection is made

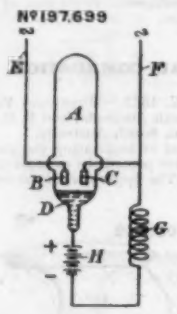


between the bus-bars and a cable in a sealing and dividing chamber which may be integral with the bus-bar chamber or independent of it and adapated to make a water-tight joint with it, but in either case it is designed to admit a cable at its further end and to permit of its conductor or conductors being bared and separated within the chamber. Where no connection is to be made to one side of the box its connecting tags are enclosed by a shallow cap which makes a water-tight joint in the same manner as a sealing and dividing chamber, and which may be filled with compound or a non-setting insulating paste to exclude moisture due to condensation.—*November 1st*, 1923.

MISCELLANEOUS.

197,699. May 14th, 1923.—IMPROVEMENTS RELATING TO RECTIFYING APPARATUS FOR ALTERNATING ELECTRIC CURRENTS, Hewittic Electric Company, Limited, 80, York-road, King's Cross, N. 1.

This invention relates to alternating-current rectifying apparatus of the mercury vapour type, and has for its object to provide simple and cheap apparatus of this character adapted for charging small accumulators of the kind generally used on mechanically propelled vehicles for lighting and starting purposes. One of the arrangements described in the specification



is shown in the accompanying diagram. The rectifying apparatus comprises an exhausted container A of glass or other suitable material provided with two anodes B C and a cathode D composed of mercury. The anodes B C are connected to the supply circuit conductors E F. The latter is also connected to one terminal of an inductance coil G. The other terminal is connected to the negative terminal of the accumulator H to be charged, the positive terminal of the accumulator being connected to the cathode D of the rectifier. The principle on which the rectifier operates is described and there are six other illustrations.—*October 18th*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the lighting service department of the British Thomson-Houston Company, 15, Savoy-street, Strand, W.C. 2. Lecture and demonstration on "Modern Methods of Electrical Illumination. 7.30 p.m.

NORTHAMPTON POLYTECHNIC INSTITUTE.—St. John-street, E.C. 1. Annual prize distribution. 7.30 p.m.

SATURDAY, DECEMBER 8TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the Coventry Graduates to the Radford works of the Daimler Company, Limited. 2.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Assembly Room, Cycling Club, Cavendish-street, Keighley. "Switzerland," by Mr. S. Gamble. 6.30 p.m.

NORTHAMPTON POLYTECHNIC INSTITUTE.—St. John-street, E.C. 1. Annual conversazione. 6.30 p.m.

MONDAY, DECEMBER 10TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper, "Cold Working of Metals, and its Influence on the Properties and Uses," by Mr. A. T. Adam. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM CENTRE.—Chamber of Commerce, New-street, Birmingham. Paper, "Automobile Body Engineering," by Mr. W. Ferrier Brown. 6.45 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: MERSEY AND NORTH WALES CENTRE.—Laboratories of Applied Electricity, University, Brownlow-street, Liverpool. Joint meeting with the Liverpool Engineering Society. "Pulverised Fuel and Efficient Steam Generation," by Mr. D. Brownlie. 7 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, Clerkenwell, E.C. 1. Paper, "Relativity," by Mr. F. M. Darton. 5.30 p.m.

SOCIETY OF ENGINEERS.—17, Victoria-street, S.W. 1. Annual general meeting. 6 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, S.W. 1. "Aeroplane Photographic Survey," by Major W. N. McLeod. 8 p.m.

MONDAY TO FRIDAY, DECEMBER 10TH TO 14TH.

THE SMITHFIELD CLUB.—The Royal Agricultural Hall, Islington. Annual Show. 10 a.m. each day.

TUESDAY, DECEMBER 11TH.

ELECTRO-HARMONIC SOCIETY.—Caxton Hall, Westminster, S.W. 1. Smoking concert. 8 p.m.

ILLUMINATING ENGINEERING SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Discussion, "Some Applications of Illuminating Engineering in Practice," will be opened by Messrs. G. Herbert and R. A. Ives. 8 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Chamber of Commerce, New-street, Birmingham. Paper, "Extrusion Problems," by Major R. M. Sheppard. 7 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Paper, "Admiralty Gun-metal," by Messrs. S. G. Homfray and F. Adam. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: WOLVERHAMPTON CENTRE.—Star and Garter Hotel, Wolverhampton. Paper, "Automobile Body Engineering," by Mr. W. Ferrier Brown. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Further discussion on "The Bio-aeration of Sewage," by Mr. A. J. Martin. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—207, Bath-street, Glasgow. Paper, "Pulverised Fuel and Efficient Steam Generation," by Mr. D. Brownlie. 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "The Modern Rotary Drilling System," by Mr. L. R. McCollum. 5.30 p.m.

INSTITUTION OF MARINE ENGINEERS.—85-88, The Minories, Tower-hill, E. 1. Adjourned discussion on "Life-saving Appliances on Large Passenger Steamers," by Mr. E. W. Blocksidge. 6.30 p.m.

INSTITUTE OF TRANSPORT: METROPOLITAN GRADUATE AND STUDENT SOCIETY.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Paper, "Ministry of Transport Requirements, with Reference to Railway Companies," by Mr. Charles Anderson. 6 p.m.

LIVERPOOL ENGINEERING SOCIETY: STUDENT SECTION.—9, The Temple, Dale-street, Liverpool. Joint meeting with the Student Section of the Mersey and North Wales Centre of the Institution of Electrical Engineers. Paper, "The Development of the Formby Power Station," by Mr. S. E. Povey. 7.30 p.m.

WEDNESDAY, DECEMBER 12TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers, Storeys-gate, Westminster, S.W. 1. Paper, "Some Experiments in the Lubrication of Commercial Vehicle Engines," by Mr. H. D. Nickinson. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—London graduates' visit to the power station of the London Electric Railways at Lots-road, Chelsea, S.W. 3 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of Birmingham graduates to the works of the Austin Motor Company, Limited, at Longbridge. 2.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Informal Meeting. Discussion, "The Lighting of Factories," to be introduced by Messrs. W. P. F. Fanghaenel and W. N. Booth. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the works of the Express Lift Company, Limited, Greycoat-street, S.W. 1.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, E.C. 4. Paper, "Recent Developments in the Production of Town Gas," by Mr. G. Evetts. 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY: CHEMICAL ENGINEERING GROUP.—Rooms of the Overseas League, 14, Elliot-street, Liverpool. Paper, "Extractions of Oils from Seeds, Nuts and Kernels," by Mr. J. T. Brewis. 6 p.m.

SOCIETY OF GLASS TECHNOLOGY.—University College, Gower-street, W.C. 1. Papers, "An Apparatus for the Calibration of Burette Tubes," by Mr. Verney Stott; "Some Factors affecting Efficiency in the Glass Trade," by Mr. Eric Farmer; "Specifications in the Glass Industry, with special reference to Soda-lime Glasses for Containers," by Professor W. E. S. Turner. 2.30 p.m.

THURSDAY, DECEMBER 13TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Institute of Marine Engineers, 85-88, The Minories, Tower-hill, E. 1. Joint meeting with the Institution of British Foundrymen. Paper, "Some Foundry Problems," by Mr. A. H. Mundey. 8 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Engineering Theatre, The University, Liverpool. Paper, "Multi-axle Vehicles, with special reference to Six-wheelers," by Mr. G. W. Watson. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Works of Vauxhall Motors, Limited, Kimpton-road, Luton. Luton graduates' meeting. Paper, "Bench Testing Methods and Apparatus," by Mr. P. H. Goffey. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Paper, "Pulverised Fuel and Efficient Steam Generation," by Mr. David Brownlie. 6 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "Gauging. Gauge Design and Inspection," by Mr. W. Allsup. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Annual dinner. Connaught Rooms.

FRIDAY, DECEMBER 14TH.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—University, St. George's-square, Sheffield. Paper, "The Metallurgical Microscope: Some Notes on its Construction and Use," by Mr. J. H. G. Monypenny. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—University College, Singleton Park, Swansea. Paper, "Some Applications of the Brinell Hardness Test," by Mr. A. L. Norbury. 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, S.W. 1. Paper, "Exhaust Valve and Cylinder Head Temperatures in High-speed Petrol Engines," by Professor A. H. Gibson and Mr. H. Wright Baker. 6 p.m.

MONDAY, DECEMBER 17TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Informal meeting. Discussion, "Students in Electricity Undertakings," opened by Mr. G. R. A. Murray. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, S.W. 1. Graduates' Section meeting. "The Management of a Sand and Flint Quarry," by Mr. F. E. A. Manning. 7 p.m.

TUESDAY, DECEMBER 18TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower-hill, E. 1. "A Basis for the Explanation of Marine Gear Troubles," by Mr. W. Sellar. 6.30 p.m.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Lecture, "Arterial Roads and their Effect upon Transport," by Mr. H. T. Chapman. 5.30 p.m.

THURSDAY, DECEMBER 20TH.

INSTITUTION OF STRUCTURAL ENGINEERS.—Denison House, 296, Vauxhall Bridge-road, S.W. 1. "Practical Designing of Structural Steelwork: Beam Connections and Clarke's Loading," by Mr. J. B. Clarke. 7.30 p.m.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, December 3rd, Sir James Crichton-Browne, treasurer and vice-president, in the chair. It was announced that the managers had elected Mr. Joseph Barcroft, F.R.S., Fullerian Professor of Physiology, in succession to Sir Arthur Keith. The special thanks of the members were returned to Dr. Rushton Parker for his donation of £100 towards the improvement of the library. M. le Duc de Broglie, Dr. C. L. Guillaume, and Professors Debye, Einstein, Groth and von Laue were elected honorary members of the Institution. Miss Day, Mrs. Grimsdale, Mrs. King, Miss Moller, Mrs. Tippinge, Sir George Beilby, Colonel Hippisley, Sir Alfred Hopkinson, Sir Richard Paget, Dr. J. H. Jeans, F.R.S., Professor Arthur Smithells, F.R.S., and Messrs. A. S. C. Ackermann, F. H. Hargrove, H. M. Hubbard, F. L. Lawson-Johnston, M. Mannaberg, E. B. Michell, A. Muller, B. J. Orsman and G. Shearer were elected members.